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Prepared by staff of the

BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • James G. Watt, Secretary

BUREAU OF MINES

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, and park and recreation areas, and for the wise use of all those resources. The Department also has a major responsibility for American Indian reservation communities and for the people who live in Island Territories under U.S. administration.

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Foreword

The Federal Government, through the Minerals Yearbook and its predecessor volumes, has reported annually on mineral industry activities for 96 years. This edition discusses the performance of the worldwide mineral industry during 1977. In addition to statistical data, the volumes provide background information to assist in interpreting the year's developments. Content of the individual volumes follows:

Volume I, Metals and Minerals, contains chapters on virtually all metallic and nonmetallic mineral commodities important to the domestic economy. In addition, it includes a general review chapter on the mineral industries, a chapter on mining and quarrying trends, and a statistical summary.

Volume II, Area Reports: Domestic, contains chapters on the mineral industry of each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Caribbean Sea, and the Commonwealth of Puerto Rico. This volume also has a statistical summary, identical to that in Volume I.

Volume III, Area Reports: International, contains the latest available mineral data on more than 130 foreign countries and discusses the importance of minerals to the economies of these nations. A separate chapter reviews the international minerals industry in general and its relationship to the world economy.

The Bureau of Mines continually strives to improve the value of its publications to its users. Therefore, the constructive comments and suggestions of readers of the Yearbook will be welcomed.

Director

Acknowledgments

The chapters of this volume were written by the State Mineral Specialists of the Bureau of Mines, located throughout the country.

The Statistical Summary chapter and the tabular material covering total State mineral production, value of mineral production by county, and economic indicators were prepared in the Division of Publication. The Branch of Publication Support Services reviewed the manuscripts upon which this volume was based, to insure statistical consistency among the tables, figures, and text between this volume and Volume I, and between this volume and those of former years.

Compilations contained in this volume were based largely on statistical data and other facts provided by the mineral industries. The Bureau gratefully acknowledges the willing contribution of these essential data by both companies and individuals.

In the collection of statistical and other mineral-industry information, the Bureau of Mines was also assisted by various State agencies through cooperative agreements. Many of the chapters in Volume II were reviewed by staff members of these agencies; in some instances the staff members collaborated in preparing the chapters and are shown as coauthors. Our sincere appreciation for this assistance is extended to the following cooperating organizations:

Alabama: Geological Survey of Alabama.
Alaska: Alaska Department of Natural Resources.
Arizona: Arizona Bureau of Mines.
Arkansas: Arkansas Geological Commission.
California: California Department of Conservation, Division of Mines and Geology.
Colorado: Division of Mines of the State of Colorado.
Connecticut: Connecticut Geological and Natural History Survey.
Delaware: Delaware Geological Survey.
Florida: Bureau of Geology, Department of Natural Resources.
Georgia: Georgia Department of Natural Resources, Geologic and Water Resources Division.
Hawaii: Hawaii Department of Land and Natural Resources.
Idaho: Idaho Bureau of Mines and Geology, Idaho Department of Lands.
Illinois: Illinois State Geological Survey.
Indiana: Geological Survey, Indiana Department of Natural Resources.
Iowa: Geological Survey of Iowa.
Kansas: State Geological Survey of Kansas.
Kentucky: Geological Survey of Kentucky.
Louisiana: Louisiana Geological Survey.
Maine: Maine Geological Survey, Department of Conservation.
Maryland: Maryland Geological Survey.
Massachusetts: State Geologist of the Commonwealth of Massachusetts.
Michigan: Geological Survey Division of the Michigan Department of Natural Resources.
Mississippi: Mississippi Geological, Economic, and Topographical Survey.

Missouri: Division of Geology and Land Survey, Department of Natural Resources.
Montana: Montana Bureau of Mines and Geology.
Nebraska: Conservation and Survey Division of the University of Nebraska, Nebraska Geological Survey.
Nevada: Nevada Bureau of Mines and Geology.
New Hampshire: New Hampshire Department of Resources and Economic Development.
New Jersey: New Jersey Division of Natural Resources, Bureau of Geology and Topography.
New York: New York State Museum and Science Service.
North Carolina: Division of Earth Resources, North Carolina Department of Natural and Economic Resources.
North Dakota: North Dakota Geological Survey.
Oklahoma: Oklahoma Geological Survey.
Oregon: Department of Geology and Mineral Industries.
Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources.
Puerto Rico: Department of Natural Resources; Environmental Quality Board.
Rhode Island: Department of Natural Resources.
South Carolina: South Carolina Geological Survey, State Development Board.
South Dakota: South Dakota State Geological Survey.
Tennessee: Tennessee Division of Geology.
Texas: Bureau of Economic Geology, The University of Texas at Austin.
Utah: Utah Geological and Mineral Survey.
Vermont: Office of the State Geologist, Agency of Environmental Conservation.
Virginia: Virginia Division of Mineral Resources.
Washington: Washington Division of Geology and Earth Resources.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Geological and Natural History Survey of Wisconsin.
Wyoming: Geological Survey of Wyoming.

Albert E. Schreck, *Editor-in-Chief*

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Statistical Summary

By Staff, Office of Technical Data Services

This chapter summarizes data on crude mineral production for the United States, its island possessions, and the Commonwealth of Puerto Rico. Included also are tables that show the principal mineral commodities exported from and imported into the United States, and that compare world and U.S. mineral production. Except for the mineral fuel commodities, the detailed data from which these tables were derived are contained in the individual commodity chapters of volume I and in the State chapters of volume II of this edition of the Minerals Yearbook.

In October 1977, responsibility for the collection of data on mineral fuels—coal, petroleum, natural gas, and natural gas liquids—was transferred to the newly created Department of Energy. Although chapters covering these commodities will no longer appear in Volume I of the Minerals Yearbook, quantity and value data have been included in most of these summary tables to maintain statistical consistency in State and national value of overall crude mineral output. This shift in responsibility has also resulted in changes to the composition of the "Nonmetals" and "Mineral Fuels" groups in table 1 and table 2. The commodities—asphalt and related bitumens (natural), carbon dioxide (natural), helium, and peat—have been removed from the "Mineral Fuels" group, and are now included under the "Nonmetals" group. There has been no change in the components of the "Metals" group.

Although crude mineral production may be measured at any of several stages of extraction and processing, the stage of measurement used in this chapter is what is normally termed "mine output." It usually refers to minerals or ores in the form in which they are first extracted from the ground, but customarily includes the output from auxiliary processing at or near the mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. In cases of gold, silver, copper, lead, zinc, and tin, the quantities are recorded on a mine basis (as the recoverable content of ore sold or treated). However, the values assigned to these quantities are based on the average selling price of refined metal, not the mine value. Mercury is measured as recovered metal and valued at the average New York price for the metal.

The weight or volume units shown are those customarily used in the particular industries producing the commodities. Values shown are in current dollars, with no adjustments made to compensate for changes in the purchasing power of the dollar.

Table 1.—Value of crude mineral production[1] in the United States, by mineral group[2]

(Million dollars)

Year	Metals	Nonmetals[2]	Total	Mineral fuels[2]	Grand total
1973	4,362	7,476	11,838	24,949	36,787
1974	5,501	8,687	[3]14,187	40,889	[3]55,077
1975	5,191	9,570	14,761	47,505	62,266
1976	6,086	10,616	16,702	52,484	[r]69,186
1977	5,810	11,701	17,511	59,575	77,086

[r] Revised.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] The commodities comprising the Mineral fuels and Nonmetals groups have been revised. See table 2 for the complete listing of the commodities which now comprise these two groups.

[3] Data do not add to total shown because of independent rounding.

Note: Beginning with 1977, data on mineral fuels supplied by the Department of Energy.

Table 2.—Mineral production[1] in the United States

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS								
Antimony ore and concentrate short tons, antimony content	661	$2,040	886	$2,131	283	$600	610	$1,320
Bauxite thousand long tons, dried equivalent	1,949	25,663	1,772	25,083	1,958	26,645	1,981	28,018
Copper (recoverable content of ores, etc.) short tons	1,597,002	2,468,964	1,413,366	1,814,763	1,605,586	2,234,975	1,503,966	2,009,297
Gold (recoverable content of ores, etc.) troy ounces	1,126,886	180,009	1,052,252	169,928	1,048,037	131,340	1,100,347	163,192
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight	84,985	1,388,447	75,695	1,620,599	76,697	1,860,102	53,880	1,417,418
Lead (recoverable content of ores, etc.) short tons	663,870	298,742	621,464	267,230	609,546	281,610	592,491	363,789
Manganese ore (35% or more Mn) short tons, gross weight	--	--	--	--	--	--	--	--
Manganiferous ore (5% to 35% Mn) do	272,908	2,323	159,225	1,413	256,633	2,260	215,893	2,249
Mercury 76-pound flasks	2,189	617	7,366	1,165	23,133	2,806	28,244	3,833
Molybdenum (content of concentrate) thousand pounds	118,163	234,658	105,170	259,328	114,527	333,494	124,974	450,421
Nickel (content of ore and concentrate) short tons	16,618	W	16,987	W	16,469	W	14,347	W
Rare-earth metal concentrates do	35,218	15,966	W	W	W	W	W	W
Silver (recoverable content of ores, etc.) thousand troy ounces	33,762	159,018	34,938	154,424	34,328	149,328	38,166	176,325
Titanium concentrate:								
Ilmenite short tons, gross weight	755,338	22,715	702,252	26,946	617,896	27,578	542,333	25,200
Rutile do	6,446	996	W	W	W	W	W	W
Tungsten ore and concentrate thousand pounds contained W	7,836	37,413	5,490	29,090	5,869	37,266	6,022	55,073
Uranium (recoverable content of U_3O_8) thousand pounds	23,227	192,560	22,936	276,102	25,146	404,830	29,481	582,249
Vanadium (recoverable in ore and concentrate) short tons	4,870	38,266	4,743	49,329	7,376	81,279	6,504	74,488
Zinc (recoverable content of ores, etc.) do	499,872	358,908	469,355	366,097	484,513	358,541	449,620	309,338
Value of items that cannot be disclosed: Beryllium, magnesium chloride for magnesium metal, manganiferous residuum (1974-1976) platinum-group metals (crude), tin, zircon concentrate, and values indicated by W	XX	73,828	XX	127,459	XX	153,452	XX	147,567
Total metals	XX	5,501,000	XX	5,191,000	XX	6,086,000	XX	5,810,000
NONMETALS (EXCEPT FUELS)								
Abrasive stones[2] short tons	3,134	717	2,953	1,060	2,696	1,404	2,200	3,236
Asbestos do	109,091	13,393	98,654	14,220	114,842	23,693	101,704	25,267
Asphalt and related bitumens, native:								
Bituminous limestone, sandstone, gilsonite do	2,021,165	16,666	1,901,715	17,838	2,011,500	17,647	1,237,000	13,874
Barite thousand short tons	1,106	16,822	1,318	21,200	1,234	28,689	1,494	30,264
Boron minerals do	1,185	128,306	1,172	158,772	1,246	184,852	1,469	236,163
Bromine thousand pounds	432,094	117,715	407,163	113,126	r460,061	r112,348	433,818	99,678
Calcium chloride short tons	739,100	24,552	594,400	29,047	648,979	32,889	710,385	45,048
Carbon dioxide, natural thousand cubic feet	966,118	237	1,070,024	279	1,356,834	298	1,617,149	351

See footnotes at end of table.

Table 2.—Mineral production[1] in the United States —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS (EXCEPT FUELS) —Continued								
Cement:								
Portland thousand short tons	75,983	$1,992,695	65,215	$2,015,625	69,163	$2,330,402	75,514	$2,727,564
Masonry do	3,371	111,106	2,868	111,801	3,267	139,564	3,752	169,101
Clays do	60,796	422,542	49,047	424,556	52,389	528,745	53,196	579,171
Diatomite short tons	664,303	50,693	573,000	45,812	^{r}631,380	54,982	648,043	63,870
Feldspar do	762,723	11,396	669,898	11,728	739,684	17,531	733,963	17,186
Fluorspar do	201,116	14,297	139,913	10,888	188,270	17,927	169,489	16,479
Garnet (abrasive) do	24,684	2,550	17,204	1,690	24,565	2,740	20,022	2,234
Gem stones[e]	NA	4,583	NA	13,900	NA	8,907	NA	8,850
Gypsum thousand short tons	11,999	52,894	9,751	44,654	11,980	59,888	13,390	74,341
Helium:								
Crude million cubic feet	184	2,208	334	4,008	^{r}587	^{r}7,048	537	6,443
High-purity do	699	18,105	745	19,915	^{r}752	^{r}18,852	957	24,280
Lime thousand short tons	21,606	473,685	19,133	523,805	20,229	609,010	19,947	666,472
Magnesium compounds from seawater and brine (except for metal) short tons, MgO equivalent	907,492	96,742	W	W	W	W	830,475	127,716
Mica:								
Scrap thousand short tons	137	5,475	135	5,219	^{r}141	^{r}5,765	176	6,480
Sheet pounds	20,000	10	5,000	3	5,000	3	W	W
Peat thousand short tons	706	10,989	746	12,294	^{r}731	^{r}12,079	726	12,520
Perlite short tons	555,000	7,024	512,000	7,282	553,000	9,397	597,000	10,753
Phosphate rock thousand metric tons	41,437	501,429	44,276	1,122,184	44,662	^{r}949,379	47,256	821,657
Potassium salts thousand short tons, K_2O equivalent	2,552	159,148	2,501	223,098	2,500	^{r}210,759	2,461	206,872
Pumice thousand short tons	3,937	9,121	3,892	11,203	4,134	10,466	4,009	11,965
Pyrites thousand long tons	424	4,238	625	4,776	750	8,213	435	7,003
Salt thousand short tons	46,536	360,763	41,030	368,063	44,191	430,959	43,412	451,579
Sand and gravel do	904,646	1,421,237	789,436	1,416,346	885,156	1,774,030	929,200	2,028,000
Sodium carbonate (natural) do	4,059	137,486	4,328	182,620	5,216	259,253	6,228	337,516
Sodium sulfate (natural) do	684	16,411	667	27,667	663	32,655	636	29,313
Stone[3] do	1,043,542	2,186,155	901,393	2,120,286	901,660	2,221,000	955,371	2,456,932
Sulfur, Frasch process thousand long tons	7,898	241,066	6,077	304,843	5,860	299,999	5,935	294,733
Talc, soapstone, pyrophyllite short tons	1,289,462	9,569	964,609	8,929	1,092,433	9,902	1,204,835	13,085
Tripoli do	85,121	623	80,562	565	124,281	776	125,661	777
Vermiculite thousand short tons	341	10,120	330	13,761	304	14,032	359	18,579

Value of items that cannot be disclosed: Aplite, emery, graphite, iodine, kyanite, lithium minerals, magnesite, greensand marl, olivine, staurolite, wollastonite, and values of nonmetal items indicated by W	XX	34,125	XX	157,180	XX	169,491	XX	56,043
Total nonmetals[r]	XX	8,687,000	XX	9,570,000	XX	10,616,000	XX	11,701,000
MINERAL FUELS								
Coal:								
Bituminous and lignite[4] thousand short tons	603,406	9,502,347	648,438	12,472,486	678,685	13,189,481	691,344	13,705,219
Pennsylvania anthracite do	6,617	144,695	6,203	198,481	6,228	209,234	5,861	205,138
Natural gas million cubic feet	21,600,522	6,573,402	20,108,661	8,945,062	19,952,438	11,571,776	20,025,463	15,825,954
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	168,152	1,107,158	151,872	878,698	149,679	985,442	590,455	4,047,473
LP gases do	447,946	1,980,769	444,086	1,893,890	437,366	2,298,647		
Petroleum (crude) do	3,202,585	21,580,549	3,056,779	23,116,059	2,976,180	24,229,540	3,009,265	25,790,722
Total mineral fuels[r]	XX	40,889,000	XX	47,505,000	XX	52,484,000	XX	59,575,000
Grand total	XX	55,077,000	XX	62,266,000	XX	[r]69,186,000	XX	77,086,000

[e] Estimate. [r] Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Grindstones, pulpstones, grinding pebbles, sharpening stones, and tube mill liners.

[3] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and soapstone, all included elsewhere in table.

[4] Includes a small quantity of anthracite mined in States other than Pennsylvania.

Note: Beginning with 1977, data on mineral fuels supplied by the Department of Energy.

Table 3.—Minerals produced in the United States and principal producing States in 1977

Mineral	Principal producing States in order of quantity	Other producing States
METALS AND NONMETALS		
Antimony ore and concentrate	Idaho and Mont.	
Aplite	Va.	
Asbestos	Calif., Vt., Ariz., N.C.	
Asphalt (native)	Tex., Utah, Ala., Mo.	
Barite	Nev., Mo., Ark., Ga	Idaho, Ill., Mont., Tenn.
Bauxite	Ark., Ala., Ga.	
Beryllium concentrate	Utah and S. Dak.	
Boron minerals	Calif.	
Bromine	Ark. and Mich.	
Calcium-chloride	Mich. and Calif.	
Carbon dioxide (natural)	N. Mex., Colo., Calif., Utah.	
Cement	Calif., Tex., Pa., Mich	Ala., Ariz., Ark., Colo., Fla., Ga., Hawaii, Idaho, Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Miss., Mo., Mont., Nebr., Nev., N. Mex., N.Y., N.C., Ohio, Okla., Oreg., S.C., S. Dak., Tenn., Utah, Va., Wash., W. Va., Wis., Wyo.
Clays	Ga., Tex., Ohio, N.C	All other States except Alaska, R.I., Vt.
Copper (mine)	Ariz., Utah, N. Mex., Mont	Alaska, Calif., Colo., Idaho, Maine, Mich., Mo., Nev., Oreg., Pa., Tenn., Wash.
Diatomite	Calif., Nev., Wash., Oreg.	
Emery	N.Y.	
Feldspar	N.C., Conn., Ga., Calif	Ariz., Colo., Maine, Okla., S. Dak., Wyo.
Fluorspar	Ill., Ky., Tex., Mont	Ariz. and Nev.
Garnet, abrasive	Idaho and N.Y.	
Gold (mine)	Nev., S. Dak., Utah, Ariz	Alaska, Calif., Colo., Idaho, Mont., N. Mex., Oreg., Tenn., Wash.
Graphite	Tex.	
Gypsum	Mich., Tex., Calif., Iowa	Ariz., Ark., Colo., Idaho, Ind., Kans., La., Mont., Nev., N. Mex., N.Y., Ohio, Okla., S. Dak., Utah, Va., Wash., Wyo.
Helium	Kans., Okla., Tex	Ariz. and N. Mex.
Iodine	Okla. and Mich.	
Iron ore	Minn., Mich., Calif., Wyo	Colo., Ga., Mo., Mont., Nev., N.J., N.Y., Pa., Tex., Utah, Wis.
Kyanite	Va. and Ga.	
Lead (mine)	Mo., Idaho, Colo., Utah	Ariz., Calif., Ill., Maine, Mont., Nev., N. Mex., N.Y., Okla., Va., Wash., Wis.
Lime	Ohio, Pa., Mo., Tex	Ala., Ariz., Ark., Calif., Colo., Conn., Fla., Hawaii, Idaho, Ill., Ind., Iowa, Kans., Ky., La., Md., Mass., Mich., Minn., Miss., Mont., Nebr., Nev., N.J., N. Mex., N.Y., N. Dak., Okla., Oreg., S. Dak., Tenn., Utah, Va., Wash., W. Va., Wis., Wyo.
Lithium minerals	N.C., Nev., Calif.	
Magnesite	Nev.	
Magnesium chloride	Tex.	
Magnesium compounds	Mich., Calif., Fla., N.J	Del., Miss., Tex., Utah.
Manganiferous ore	Minn., N. Mex., S.C.	
Marl, greensand	N.J.	
Mercury	Nev. and Calif.	
Mica, scrap	N.C., S.C., N. Mex., Ala	Ariz., Conn., Ga., Pa., S. Dak.
Molybdenum	Colo., Ariz., N. Mex., Utah	Calif. and Nev.
Nickel	Oreg.	
Olivine	N.C. and Wash.	
Peat	Mich., Fla., Ind., Ill.	Calif., Colo., Ga., Iowa, Maine, Md., Mass., Minn., Mont., N.J., N. Mex., N.Y., N. Dak., Ohio, Pa., S.C., Wash., Wis.
Perlite	N. Mex., Ariz., Calif., Idaho	Colo. and Nev.
Phosphate rock	Fla., Idaho, N.C., Tenn	Calif., Mo., Mont., Utah, Wyo.
Potassium salts	N. Mex., Calif., Utah.	
Pumice	Oreg., Nev., Calif., Ariz	Colo., Hawaii, Idaho, Mont., N Mex., Okla., Utah, Wash.
Pyrites ore and concentrate	Tenn., Colo., Ariz.	
Rare-earth metal concentrate	Calif. and Fla.	
Salt	La., Tex., N.Y., Mich	Ala., Ariz., Calif., Colo., Kans., Nev., N. Mex., N. Dak., Ohio, Okla., Utah, W. Va.
Sand and gravel	Calif., Alaska, Tex., Ohio	All other States.
Silver (mine)	Idaho, Ariz., Colo., Mont	Alaska, Calif., Ill., Mich., Mo., Nev., N. Mex., N.Y., Oreg., S. Dak., Tenn., Utah, Va., Wash.
Sodium carbonate (natural)	Wyo. and Calif.	
Sodium sulfate (natural)	Calif., Tex., Utah.	
Staurolite	Fla.	
Stone	Tex., Pa., Ill., Mo	All other States except Del. and N. Dak.

Table 3.—Minerals produced in the United States and principal producing States in 1977 —Continued

Mineral	Principal producing States in order of quantity	Other producing States
METALS AND NONMETALS — Continued		
Sulfur (Frasch)	Tex. and La.	
Talc, soapstone, pyrophyllite	Vt., Tex., Mont., N.Y	Ark., Calif., Ga., Nev., N.C., Oreg., Va., Wash.
Tin	Colo.	
Titanium concentrate	N.J., Fla., N.Y.	
Tripoli	Ill., Okla., Ark., Pa.	
Tungsten concentrate	Calif., Colo., Nev	Alaska, Ariz., Idaho, Mont., Oreg., Utah, Wash.
Uranium	N. Mex., Wyo., Utah, Colo	Tex. and Wash.
Vanadium	Ark., Colo., Utah, Idaho	N. Mex.
Vermiculite	Mont. and S.C	Tex.
Wollastonite	N.Y.	
Zinc (mine)	Tenn., Mo., N.Y., Colo	Ariz., Calif., Idaho, Ill., Maine, Mont., Nev., N.J., N. Mex., Okla., Pa., Utah, Va., Wash., Wis.
Zircon concentrate	Fla.	
MINERAL FUELS		
Coal	Ky., W. Va., Pa., Ill	Ala., Alaska, Ariz., Ark., Colo., Ga., Ind., Iowa, Kans., Md., Mo., Mont., N. Mex., N. Dak., Ohio, Okla., Tenn., Tex., Utah, Va., Wash., Wyo.
Natural gas	La., Tex., Okla., N. Mex	Ala., Alaska, Ariz., Ark., Calif., Colo., Fla., Ill., Ind., Kans., Ky., Md., Mich., Miss., Mo., Mont., Nebr., N.Y., N. Dak., Ohio, Pa., Tenn., Utah, Va., W. Va., Wyo.
Natural gas liquids	Tex., La., N. Mex., Okla	Ala., Alaska, Ark., Calif., Colo., Fla., Ill., Kans., Ky., Mich., Miss., Mont., Nebr., N. Dak., Pa., S. Dak., Utah, W. Va., Wyo.
Petroleum, crude	Tex., La., Calif., Alaska	Ala., Ariz., Ark., Colo., Fla., Ill., Ind., Kans., Ky., Mich., Miss., Mo., Mont., Nebr., Nev., N. Mex., N.Y., N. Dak., Ohio, Okla., Pa., S. Dak., Tenn., Utah, Va., W. Va., Wyo.

Table 4.—Value of mineral production in the United States and principal minerals produced in 1977

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$1,159,952	19	1.50	Coal, petroleum, cement, stone.
Alaska	1,233,519	18	1.60	Petroleum, sand and gravel, natural gas, stone.
Arizona	1,621,256	12	2.10	Copper, molybdenum, coal, cement.
Arkansas	574,469	25	.75	Petroleum, bromine, natural gas, cement.
California	4,311,824	3	5.59	Petroleum, cement, natural gas, sand and gravel.
Colorado	1,397,039	15	1.81	Petroleum, molybdenum, coal, natural gas.
Connecticut	48,708	44	.06	Stone, sand and gravel, feldspar, lime.
Delaware	[1]2,091	50	(2)	Sand and gravel, magnesium compounds, clays, gem stones.
Florida	1,618,557	13	2.09	Phosphate rock, petroleum, stone, cement.
Georgia	486,256	28	.63	Clays, stone, cement, sand and gravel.
Hawaii	39,980	47	.05	Stone, cement, sand and gravel, pumice.
Idaho	252,670	32	.33	Phosphate rock, silver, lead, zinc.
Illinois	1,663,280	10	2.15	Coal, petroleum, stone, sand and gravel.
Indiana	697,558	23	.91	Coal, cement, stone, petroleum.
Iowa	238,208	33	.31	Cement, stone, sand and gravel, gypsum.
Kansas	1,369,497	16	1.78	Petroleum, natural gas, natural gas liquids, cement.
Kentucky	3,217,860	5	4.17	Coal, stone, petroleum, natural gas.
Louisiana	10,911,885	2	14.16	Natural gas, petroleum, natural gas liquids, sulfur.
Maine	43,225	45	.06	Sand and gravel, cement, zinc, stone.
Maryland	186,699	36	.24	Coal, stone, cement, sand and gravel.
Massachusetts	77,268	43	.10	Stone, sand and gravel, lime, clays.
Michigan	1,622,547	11	2.10	Petroleum, iron ore, cement, natural gas.
Minnesota	875,603	22	1.14	Iron ore, sand and gravel, stone, lime.
Mississippi	492,234	27	.64	Petroleum, natural gas, cement, sand and gravel.
Missouri	893,372	21	1.16	Lead, cement, stone, iron ore.
Montana	691,188	24	.90	Petroleum, coal, copper, natural gas.
Nebraska	144,029	39	.18	Petroleum, cement, sand and gravel, stone.
Nevada	270,845	31	.35	Copper, gold, sand and gravel, cement.
New Hampshire	20,701	48	.03	Sand and gravel, stone, clays, gem stones.
New Jersey	117,060	40	.15	Stone, sand and gravel, zinc, titanium concentrate.
New Mexico	2,910,804	8	3.78	Natural gas, petroleum, natural gas liquids, uranium.
New York	461,807	29	.60	Cement, stone, salt, sand and gravel.
North Carolina	231,511	34	.30	Stone, phosphate rock, sand and gravel, cement.
North Dakota	272,066	30	.35	Petroleum, coal, sand and gravel,natural gas liquids.
Ohio	1,607,454	14	2.08	Coal, natural gas, petroleum, stone.
Oklahoma	3,497,447	4	4.54	Petroleum, natural gas, natural gas liquids, coal.
Oregon	109,132	42	.14	Stone, sand and gravel, cement, nickel.
Pennsylvania	3,043,964	7	3.95	Coal, cement, stone, natural gas.
Rhode Island	6,299	49	.01	Sand and gravel, stone, gem stones.
South Carolina	144,201	38	.18	Cement, stone, clays, sand and gravel.
South Dakota	110,740	41	.14	Gold, cement, stone, sand and gravel.
Tennessee	521,371	26	.68	Coal, stone, zinc, cement.
Texas	19,519,631	1	25.32	Petroleum, natural gas, natural gas liquids, cement.
Utah	1,085,339	20	1.41	Petroleum, copper, coal, uranium.
Vermont	41,454	46	.05	Stone, asbestos, sand and gravel, talc.
Virginia	1,341,686	17	1.74	Coal, stone, lime, cement.
Washington	216,124	35	.28	Cement, coal, sand and gravel, stone.
West Virginia	3,208,068	6	4.16	Coal, natural gas, petroleum, natural gas liquids.
Wisconsin	150,128	37	.19	Sand and gravel, stone, iron ore, lime.
Wyoming	2,331,349	9	3.02	Petroleum, coal, sodium compounds, natural gas.
Total	77,086,000	--	100.00	

[1] Incomplete total.
[2] Less than 1/2 unit.

Table 5.—Value of mineral production per capita and per square mile in 1977, by State

State	Area (square miles)	1977 population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama	51,609	3,690	$1,159,952	22,476	15	314	16
Alaska	586,412	407	1,233,519	2,104	45	3,031	2
Arizona	113,909	2,296	1,621,256	14,233	20	706	11
Arkansas	53,104	2,144	574,469	10,818	25	268	18
California	158,693	21,896	4,311,824	27,171	12	197	23
Colorado	104,247	2,619	1,397,039	13,401	21	533	13
Connecticut	5,009	3,108	43,708	8,726	30	14	47
Delaware	2,057	582	[1]2,091	1,017	50	4	50
Florida	58,560	8,452	1,618,557	27,639	11	191	24
Georgia	58,876	5,048	486,256	8,259	31	96	32
Hawaii	6,450	895	39,980	6,198	32	45	39
Idaho	83,557	857	252,670	3,024	41	295	17
Illinois	56,400	11,245	1,663,280	29,491	9	148	29
Indiana	36,291	5,330	697,558	19,221	16	130	30
Iowa	56,290	2,879	238,208	4,232	38	83	35
Kansas	82,264	2,326	1,369,497	16,648	18	589	12
Kentucky	40,395	3,458	3,217,860	79,660	3	931	8
Louisiana	48,523	3,921	10,911,885	224,881	1	2,783	3
Maine	33,215	1,085	43,225	1,301	48	40	42
Maryland	10,577	4,139	186,699	17,651	17	45	40
Massachusetts	8,257	5,782	77,268	9,358	28	13	48
Michigan	58,216	9,129	1,622,547	27,871	10	178	26
Minnesota	84,068	3,975	875,603	10,415	26	220	21
Mississippi	47,716	2,389	492,234	10,316	27	206	22
Missouri	69,686	4,801	893,372	12,820	22	186	25
Montana	147,138	761	691,188	4,698	34	908	9
Nebraska	77,227	1,561	144,029	1,865	46	92	33
Nevada	110,540	633	270,845	2,450	43	428	14
New Hampshire	9,304	849	20,701	2,225	44	24	45
New Jersey	7,836	7,329	117,060	14,939	19	16	46
New Mexico	121,666	1,190	2,910,804	23,925	13	2,446	4
New York	49,576	17,924	461,807	9,315	29	26	44
North Carolina	52,586	5,525	231,511	4,403	36	42	41
North Dakota	70,665	653	272,066	3,850	39	417	15
Ohio	41,222	10,701	1,607,454	38,995	7	150	28
Oklahoma	69,919	2,811	3,497,447	50,021	6	1,244	7
Oregon	96,981	2,376	109,132	1,125	49	46	38
Pennsylvania	45,333	11,785	3,043,964	67,147	5	258	20
Rhode Island	1,214	935	6,299	5,189	33	7	49
South Carolina	31,055	2,876	144,201	4,643	35	50	37
South Dakota	77,047	689	110,740	1,437	47	161	27
Tennessee	42,244	4,299	521,371	12,342	24	121	31
Texas	267,338	12,830	19,519,631	73,015	4	1,521	6
Utah	84,916	1,268	1,085,339	12,781	23	856	10
Vermont	9,609	485	41,454	4,314	37	85	34
Virginia	40,817	5,135	1,341,686	32,871	8	261	19
Washington	68,192	3,658	216,124	3,169	40	59	36
West Virginia	24,181	1,859	3,208,068	132,669	2	1,725	5
Wisconsin	56,154	4,651	150,128	2,675	42	32	43
Wyoming	97,914	406	2,331,349	23,810	14	5,742	1
Total[2]	3,615,055	215,642	77,086,000	21,324	XX	356	XX

XX Not applicable.

[1] Incomplete total.

[2] Excludes Washington, D.C., with an area of 67 square miles and a population of 690,000 (which had no mineral production).

Table 6.—Mineral production[1] in the United States, by State

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA								
Cement:								
Masonry thousand short tons	314	$11,322	262	$10,253	314	$13,671	345	$14,255
Portland do	2,190	61,990	1,968	62,599	2,134	70,365	2,351	79,302
Clays[2] do	2,995	13,298	2,231	9,077	2,239	10,325	2,677	21,984
Coal (bituminous) do	19,824	432,036	22,644	600,767	21,537	611,069	21,545	622,187
Lime do	1,054	22,346	985	29,404	1,009	32,753	1,149	39,213
Natural gas million cubic feet	27,865	20,704	37,814	32,898	41,427	40,806	57,227	84,124
Petroleum (crude) thousand 42-gallon barrels	13,323	113,808	13,477	136,541	14,706	155,437	18,252	176,540
Sand and gravel thousand short tons	12,454	19,120	9,232	17,376	12,023	20,933	14,372	35,204
Stone do	[3]23,773	[3]60,231	22,252	61,515	23,832	65,429	25,262	74,364
Value of items that cannot be disclosed: Asphalt (native), bauxite, clay (bentonite), iron ore, usable (1974-75), mica (scrap), natural gas liquids, salt, stone (dimension 1974), talc (1974-75)	XX	9,891	XX	8,543	XX	8,748	XX	12,779
Total	XX	764,746	XX	968,973	XX	1,029,536	XX	1,159,952
ALASKA								
Barite thousand short tons	20	401	2	30	--	--	--	--
Coal (bituminous) do	700	W	766	W	706	W	705	W
Gem stones	NA	57	NA	57	NA	60	NA	60
Gold (recoverable content of ores, etc.) troy ounces	9,146	1,461	14,980	2,419	22,887	2,868	18,962	2,812
Lead (recoverable content of ores, etc.) short tons	--	--	--	--	14	6	--	--
Natural gas million cubic feet	128,935	21,919	160,270	48,402	166,072	64,602	187,889	75,531
Petroleum (crude) thousand 42-gallon barrels	70,603	347,408	69,834	364,630	63,398	318,789	169,201	988,877
Sand and gravel thousand short tons	43,644	22,954	48,145	25,780	74,208	204,738	66,426	134,251
Silver (recoverable content of ores, etc.) thousand troy ounces	1	3	W	W	3	14	2	8
Stone thousand short tons	5,484	12,947	8,877	26,649	6,727	20,092	4,008	17,494
Tin metric tons	W	W	11	60	--	--	--	--
Value of items that cannot be disclosed: Copper (1974, 1977), mercury (1974), natural gas liquids, platinum-group metals (1974-76), tungsten (1977), and values indicated by W	XX	11,453	XX	12,718	XX	14,019	XX	14,486
Total	XX	418,603	XX	480,745	XX	625,188	XX	1,233,519

ARIZONA								
Clays ---- thousand short tons	199	622	129	483	[2]28	[2]361	[2]33	[2]444
Coal (bituminous) ---- do	6,448	W	6,986	W	10,420	W	W	W
Copper ---- short tons	858,783	1,327,678	813,211	1,044,162	1,024,421	1,425,994	923,778	1,234,168
Gem stones	NA	1,500	NA	5,000	NA	4,000	NA	4,500
Gold (recoverable content of ores, etc.) ---- troy ounces	90,586	14,470	85,790	13,854	102,062	12,790	90,167	13,373
Gypsum ---- thousand short tons	141	473	117	419	139	529	187	775
Lead (recoverable content of ores, etc.) ---- short tons	1,059	476	420	181	338	156	318	195
Lime ---- thousand short tons	422	9,071	512	12,444	546	16,115	474	15,528
Mica (scrap) ---- do	2	82	2	65	W	W	W	W
Molybdenum (content of concentrate) ---- thousand pounds	28,346	57,067	25,030	61,411	31,073	89,148	34,574	120,497
Natural gas ---- million cubic feet	224	45	208	58	262	74	240	80
Petroleum (crude) ---- thousand 42-gallon barrels	740	3,885	635	3,332	519	2,724	427	2,243
Pumice ---- thousand short tons	846	865	856	1,294	802	1,240	621	1,226
Sand and gravel ---- do	23,417	41,906	17,222	36,490	[4]18,131	[4]40,184	22,313	49,946
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	6,356	29,935	6,286	27,783	7,615	33,126	6,828	31,546
Stone ---- thousand short tons	4,932	11,479	3,404	11,030	4,147	13,921	5,367	16,495
Zinc (recoverable content of ores, etc.) ---- short tons	9,699	6,964	8,655	6,751	9,501	7,030	4,380	3,013
Value of items that cannot be disclosed: Asbestos, beryl concentrate (1976), cement, clays (ball and common, 1976-77, fire clay, 1977), feldspar, fluorspar (1976-77), helium (high purity, 1974-76), iron ore (1974-76), perlite, pyrite, salt (1975-77), sand and gravel (industrial, 1976), tungsten, and values indicated by W	XX	55,716	XX	63,666	XX	79,229	XX	127,227
Total	XX	1,562,234	XX	1,288,423	XX	1,726,621	XX	1,621,256
ARKANSAS								
Bauxite ---- thousand long tons, dried equivalent	1,731	23,597	1,543	22,956	1,667	24,481	1,676	24,851
Clays ---- thousand short tons	984	1,597	995	2,232	1,047	3,396	988	5,407
Coal (bituminous) ---- do	455	9,673	488	16,000	534	19,310	563	21,431
Gem stones	NA	60	NA	70	NA	85	NA	85
Iron ore ---- thousand long tons, gross weight	4	W	([5])	14	--	--	--	--
Lime ---- thousand short tons	187	3,189	170	3,848	182	4,900	152	4,552
Natural gas ---- million cubic feet	123,975	32,234	116,237	40,334	109,533	58,052	104,096	60,896
Natural gas liquids:								
Natural gasoline and cycle products ---- thousand 42-gallon barrels	199	1,344	196	1,360	203	1,422	555	5,152
LP gases ---- do	418	2,491	407	2,377	408	2,440		
Petroleum (crude) ---- do	16,527	122,817	16,133	143,336	18,097	174,636	20,202	200,606
Sand and gravel ---- thousand short tons	14,878	29,922	12,415	25,794	[4]14,736	[4]25,848	16,110	36,091
Stone ---- do	20,381	38,905	17,419	38,796	[3]17,701	[3]39,713	18,323	45,816

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ARKANSAS—Continued								
Value of items that cannot be disclosed: Abrasive stones, barite, bromine, cement, gypsum, phosphate rock (1975-76), sand and gravel (industrial, 1976), stone (dimension, 1976), soapstone, tripoli, vanadium, and values indicated by W	XX	$140,589	XX	$139,324	XX	r$182,744	XX	$169,582
Total	XX	406,418	XX	436,441	XX	r537,027	XX	574,469
CALIFORNIA								
Asbestos ......short tons	58,331	5,697	W	W	78,390	15,706	76,247	18,372
Barite ......thousand short tons	4	W	1	W	--	--	--	--
Boron minerals ......do	1,185	128,306	1,172	158,772	1,246	184,852	1,469	236,163
Cement ......do	8,264	210,520	7,327	232,584	7,897	293,693	9,271	406,185
Clays ......do	2,497	7,626	[2]2,387	[2]7,373	2,295	13,570	2,655	12,179
Copper (recoverable content of ores, etc.) ......short tons	194	300	344	441	375	522	221	295
Diatomite ......do	W	W	354	31,186	386	37,372	397	43,405
Gem stones	NA	220	NA	220	NA	231	NA	230
Gold (recoverable content of ores, etc.) ......troy ounces	5,049	807	9,606	1,551	10,392	1,302	5,704	846
Gypsum ......thousand short tons	1,716	6,642	1,446	6,332	1,647	7,897	1,629	8,500
Lead (recoverable content of ores, etc.) ......short tons	35	16	66	28	54	25	3	2
Lime ......thousand short tons	600	14,877	595	18,626	638	23,324	598	24,074
Magnesium compounds from seawater and bitterns (partly estimated) short tons, MgO content	163,847	18,356	W	W	W	W	W	W
Mercury ......76-pound flasks	1,311	370	W	W	296	36	W	W
Natural gas ......million cubic feet	365,354	160,756	318,308	222,816	354,334	333,074	311,462	364,099
Natural gas liquids:								
Natural gasoline and cycle products ......thousand 42-gallon barrels	5,709	26,104	4,847	29,543	4,626	31,655	8,117	61,873
LP gases ......do	5,095	29,296	4,481	20,568	4,151	25,487		
Peat ......thousand short tons	14	322	W	W	W	W	W	W
Petroleum (crude) ......thousand 42-gallon barrels	323,003	1,710,350	322,199	1,943,048	326,021	2,005,577	349,609	2,555,965
Pumice ......thousand short tons	909	3,219	348	2,762	705	3,245	636	3,838
Rare-earth metal concentrates ......short tons	34,284	15,798	W	W	W	W	W	W
Sand and gravel ......thousand short tons	105,191	176,213	88,445	168,248	96,592	202,272	109,135	250,951
Silver (recoverable content of ores, etc.) ......thousand troy ounces	42	197	80	353	57	249	58	267
Stone ......thousand short tons	45,709	91,891	33,152	72,740	32,377	75,352	34,037	81,142
Talc, soapstone, pyrophyllite ......short tons	163,841	1,676	152,978	1,598	56,871	1,513	95,602	2,373

Zinc (recoverable content of ores, etc.)	do	8	6	206	161	170	126	2	1
Value of items that cannot be disclosed: Bromine (1974-75), calcium-magnesium chloride, carbon dioxide, cement (masonry, 1977), clays (ball and kaolin, 1975), feldspar, iron ore, lithium minerals, molybdenum, perlite, phosphate rock (1976-77), potassium salts, salt, sodium carbonate and sulfate, tungsten concentrate, and values indicated by W		XX	187,684	XX	233,987	XX	226,293	XX	241,064
Total		XX	2,797,249	XX	3,152,937	XX	3,483,373	XX	4,311,824
COLORADO									
Carbon dioxide	thousand cubic feet	123,106	W	229,382	W	317,720	W	W	W
Clays	thousand short tons	663	1,588	480	1,101	[2]479	[2]1,976	[2]961	[2]4,712
Coal (bituminous)	do	6,896	64,677	8,219	135,872	9,437	144,364	11,989	201,289
Copper (recoverable content of ores, etc.)	short tons	3,012	4,657	3,560	4,571	2,431	3,384	1,896	2,533
Gem stones		NA	135	NA	145	NA	142	NA	100
Gold (recoverable content of ores, etc.)	troy ounces	52,083	8,320	55,483	8,960	50,764	6,362	72,668	10,777
Gypsum	thousand short tons	191	800	185	782	215	984	211	1,121
Lead (recoverable content of ore, etc.)	short tons	24,609	11,074	27,088	11,648	26,749	12,358	22,994	14,118
Lime	thousand short tons	198	3,815	198	4,577	185	4,406	180	5,413
Natural gas	million cubic feet	144,629	28,926	171,629	44,624	183,972	88,307	188,792	152,922
Natural gas liquids:									
Natural gasoline and cycle products	thousand 42-gallon barrels	1,574	9,319	1,742	9,378	1,904	13,403	9,381	67,066
LP gases	do	2,580	14,190	4,821	22,803	6,505	38,249		
Peat	thousand short tons	30	201	37	280	33	238	32	195
Petroleum (crude)	thousand 42-gallon barrels	37,508	283,904	38,089	365,654	38,992	376,273	39,460	398,457
Sand and gravel	thousand short tons	23,793	39,674	20,019	34,850	[4]20,160	[4]32,900	[4]23,910	[4]50,527
Silver (recoverable content of ores, etc.)	thousand troy ounces	2,784	13,113	3,366	14,878	4,083	17,762	4,663	21,545
Stone	thousand short tons	6,572	15,109	5,315	10,940	5,294	12,555	5,602	14,350
Zinc (recoverable content of ores, etc.)	short tons	49,489	35,533	48,460	37,799	50,621	37,460	40,267	27,704
Value of items that cannot be disclosed: Cement, clay (bentonite, 1976-77), feldspar, fluorspar (1974), iron ore, molybdenum, perlite, pumice, pyrites, salt, sand and gravel (industrial, 1976-77), tin, tungsten, uranium, vanadium, and values indicated by W		XX	215,264	XX	249,211	XX	319,043	XX	424,210
Total		XX	750,299	XX	958,073	XX	1,110,166	XX	1,397,039
CONNECTICUT									
Clays	thousand short tons	156	363	116	307	130	427	95	250
Gem stones		NA	15	NA	W	NA	W	NA	W
Lime	thousand short tons	33	1,148	23	1,013	24	1,103	29	1,412
Mica, scrap	do	2	W	W	W	W	W	W	W
Sand and gravel	do	6,345	11,272	4,900	10,040	6,414	12,978	[4]8,543	[4]18,316

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
CONNECTICUT—Continued								
Stone ---- thousand short tons	8,457	$21,134	7,322	$20,117	6,016	$17,598	6,989	$20,559
Value of items that cannot be disclosed: Feldspar, mica (sheet, 1974), sand and gravel (industrial, 1977), and values indicated by W	XX	1,430	XX	1,533	XX	2,212	XX	3,171
Total	XX	35,362	XX	33,010	XX	34,318	XX	43,708
DELAWARE								
Clays ---- thousand short tons	14	8	9	6	11	8	11	7
Gem stones	NA	2	NA	W	NA	W	NA	W
Sand and gravel ---- thousand short tons	2,396	3,783	976	1,900	1,117	1,829	1,351	2,084
Value of items that cannot be disclosed: Other nonmetals and values indicated by W	XX	W	XX	W	XX	W	XX	W
Total	XX	[6]3,793	XX	[6]1,906	XX	[6]1,837	XX	[6]2,091
FLORIDA								
Cement:								
Masonry ---- thousand short tons	235	4,737	W	W	W	W	W	W
Portland ---- do	2,562	75,133	1,721	62,525	1,949	67,832	2,540	87,561
Clays ---- do	[2]808	[2]14,261	712	17,063	680	20,672	581	[2]22,313
Lime ---- do	185	5,315	199	7,708	179	7,798	165	7,350
Natural gas ---- million cubic feet	38,137	20,441	44,383	43,185	43,165	42,388	48,171	52,458
Peat ---- thousand short tons	67	616	82	1,037	79	1,287	125	1,396
Petroleum ---- thousand 42-gallon barrels	36,351	351,331	41,877	490,258	44,460	499,573	46,641	544,254
Sand and gravel ---- thousand short tons	24,372	33,400	13,237	20,199	13,204	19,164	20,218	38,989
Stone[3] ---- do	54,560	100,378	39,071	73,372	38,606	74,412	48,558	101,435
Titanium concentrates (rutile) ---- short tons	6,446	996	W	W	W	W	W	W
Value of items that cannot be disclosed: Clay (kaolin, 1974, 1976-77), magnesium compounds, natural gas liquids, phosphate rock, rare-earth metal concentrate, staurolite, stone (dimension), titanium concentrate (ilmenite), zircon concentrate, and values indicated by W	XX	437,287	XX	1,060,153	XX	919,106	XX	762,801
Total	XX	1,043,895	XX	1,775,500	XX	1,652,232	XX	1,618,557

GEORGIA								
Cement:								
Masonry ---- thousand short tons	40	1,304	W	W	W	W	W	W
Portland ---- do	1,150	31,535	828	25,822	930	30,085	1,192	37,711
Clays ---- do	[2]7,692	[2]203,936	6,156	195,300	7,471	273,145	7,554	288,223
Coal (bituminous) ---- do	--	--	W	W	186	6,152	W	W
Peat ---- do	1	6	(5)	5	W	W	W	W
Sand and gravel ---- do	4,989	9,639	5,105	8,818	4,835	8,387	5,141	13,207
Stone ---- do	40,321	105,582	30,084	91,157	31,855	98,806	38,105	119,852
Talc ---- short tons	33,850	102	27,400	82	W	W	23,540	63
Value of items that cannot be disclosed: Barite, bauxite, fire clay (1974), feldspar, iron ore, kyanite, mica (scrap), rare-earth metal concentrate (1974), titanium concentrate (1974), zircon concentrate (1974), and values indicated by W ----	XX	10,996	XX	12,203	XX	11,904	XX	27,200
Total ----	XX	363,100	XX	333,387	XX	428,479	XX	486,256
HAWAII								
Cement:								
Masonry ---- thousand short tons	14	706	13	762	11	663	10	607
Portland ---- do	487	16,405	456	19,942	328	17,747	320	16,315
Gem stones ----	NA	W	NA	W	NA	W	NA	W
Lime ---- thousand short tons	6	221	6	250	W	W	W	W
Pumice, pumicite, volcanic ash ---- do	385	792	318	912	330	636	260	574
Sand and gravel ---- do	990	2,379	671	2,460	573	1,634	771	2,452
Stone ---- do	[3]7,638	[3]21,370	7,569	25,319	[3]6,092	[3]21,193	5,758	19,880
Value of items that cannot be disclosed: Clays, stone (dimension, 1974, 1976), and values indicated by W ----	XX	169	XX	65	XX	379	XX	152
Total ----	XX	42,042	XX	49,710	XX	42,252	XX	39,980
IDAHO								
Antimony ore and concentrate ---- short tons, antimony content	445	W	W	W	133	282	446	W
Clays ---- thousand short tons	[2]9	[2]10	30	284	W	W	W	W
Copper (recoverable content of ores, etc.) ---- short tons	2,841	4,393	3,192	4,099	3,362	4,680	4,052	5,413
Gem stones ----	NA	120	NA	120	NA	126	NA	100
Gold (recoverable content of ores, etc.) ---- troy ounces	2,898	463	2,529	408	2,755	345	12,894	1,912
Lead (recoverable content of ores, etc.) ---- short tons	51,717	23,273	50,395	21,670	53,636	24,780	47,258	29,016
Pumice ---- thousand short tons	108	182	111	187	W	W	W	W
Sand and gravel ---- do	7,665	10,484	6,881	12,768	[4]6,549	[4]11,504	[4]7,750	[4]15,282

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IDAHO—Continued								
Silver (recoverable content of ores, etc.) thousand troy ounces	12,436	$58,572	13,868	$61,297	11,561	$50,292	15,292	$70,649
Stone thousand short tons	3,528	9,868	3,316	8,952	[3]3,462	[3]9,122	[3]3,077	[3]8,005
Zinc (recoverable content of ores, etc.) short tons	39,469	28,339	40,926	31,922	46,586	34,473	30,998	21,327
Value of items that cannot be disclosed: Barite, cement, clays (selected, 1974, 1976-77), garnet (abrasive), gypsum, iron ore (1974-75), lime, perlite, phosphate rock, sand and gravel (industrial, 1976-77), stone (dimension, 1976-77), tungsten concentrate, vanadium, and values indicated by W	XX	72,854	XX	92,081	XX	74,642	XX	100,966
Total	XX	208,558	XX	233,788	XX	210,246	XX	252,670
ILLINOIS								
Cement:								
Masonry thousand short tons	69	3,228	W	W	W	W	W	W
Portland do	1,460	41,023	1,374	42,756	1,632	53,524	1,823	61,849
Clays[2] do	1,587	3,744	1,366	3,249	1,309	3,272	951	5,117
Coal (bituminous) do	58,215	582,010	59,537	871,377	58,239	925,968	53,493	924,506
Fluorspar short tons	151,898	12,247	99,898	8,957	142,666	14,563	131,218	13,941
Gem stones	NA	2	NA	2	NA	2	NA	2
Lead (recoverable content of ores, etc.) short tons	493	222	W	W	W	W	W	W
Natural gas million cubic feet	1,436	574	1,440	1,008	1,556	1,533	1,003	1,204
Peat thousand short tons	96	1,412	96	1,511	87	763	82	1,478
Petroleum (crude) thousand 42-gallon barrels	27,553	244,395	26,067	273,182	26,272	267,449	25,608	314,293
Sand and gravel thousand short tons	42,705	68,566	39,000	83,515	38,784	87,152	37,633	101,230
Stone do	63,231	121,763	60,640	130,104	61,862	141,543	57,077	136,073
Zinc (recoverable content of ores, etc.) short tons	4,104	2,947	W	W	W	W	W	W
Value of items that cannot be disclosed: Barite, clay (fuller's earth), copper (1974), lime, natural gas liquids, silver, tripoli, and values indicated by W	XX	65,517	XX	74,937	XX	85,396	XX	103,587
Total	XX	1,147,650	XX	1,490,598	XX	1,581,165	XX	1,663,280
INDIANA								
Cement:								
Masonry thousand short tons	W	W	343	12,263	396	14,270	W	W
Portland do	W	W	2,185	63,077	2,490	73,432	W	W

Clays ____ do ____	1,092	1,947	1,094	1,961	1,265	2,308	1,268	2,237
Coal (bituminous) ____ do ____	23,726	198,410	25,124	280,130	25,369	312,990	27,797	384,493
Natural gas ____ million cubic feet ____	176	25	346	135	192	100	183	126
Peat ____ thousand short tons ____	71	946	76	1,918	[r]66	[r]829	51	759
Petroleum (crude) ____ thousand 42-gallon barrels ____	4,919	42,402	4,632	48,821	4,630	50,421	5,314	66,212
Sand and gravel ____ thousand short tons ____	26,077	35,656	21,641	35,234	25,884	45,521	26,248	50,089
Stone ____ do ____	[3]31,031	[3]64,106	28,947	68,850	28,450	72,205	26,984	73,196
Value of items that cannot be disclosed: Abrasive stone, gypsum, lime, sandstone (1974), and values indicated by W ____	XX	97,198	XX	[r]29,211	XX	34,358	XX	120,446
Total ____	XX	440,690	XX	541,600	XX	[r]606,434	XX	697,558
IOWA								
Cement:								
Masonry ____ thousand short tons ____	65	2,660	62	2,933	76	4,143	86	5,052
Portland ____ do ____	2,424	64,156	2,258	73,786	2,438	86,107	2,645	99,383
Clays ____ do ____	960	1,869	959	1,916	1,017	2,245	883	2,461
Coal (bituminous) ____ do ____	590	4,591	622	6,891	616	8,351	513	6,518
Gem stones ____	NA	W	NA	W	NA	1	NA	1
Gypsum ____ thousand short tons ____	1,397	7,142	1,208	6,546	1,486	8,288	1,593	10,035
Sand and gravel ____ do ____	17,091	26,104	15,410	26,844	[4]15,206	[4]26,277	[4]16,600	[4]33,290
Stone ____ do ____	32,342	66,119	30,336	73,732	[3]30,272	[3]75,921	[3]29,183	[3]76,964
Value of items that cannot be disclosed: Lime, peat, sand and gravel (industrial, 1976-77), stone (dimension, 1976-77), and values indicated by W ____	XX	4,079	XX	3,092	XX	4,694	XX	4,504
Total ____	XX	176,720	XX	195,740	XX	216,027	XX	238,208
KANSAS								
Cement:								
Masonry ____ thousand short tons ____	64	2,203	57	2,311	72	3,281	79	3,742
Portland ____ do ____	1,940	46,940	1,832	55,033	2,005	66,478	2,020	72,815
Clays ____ do ____	1,311	1,785	1,178	1,604	[2]1,064	[2]1,869	[2]1,117	[2]1,965
Coal (bituminous) ____ do ____	718	5,463	479	9,481	590	11,473	897	16,983
Helium (high-purity) ____ million cubic feet ____	499	11,477	497	11,928	503	11,066	W	W
Lime ____ thousand short tons ____	28	535	W	W	W	W	15	409
Natural gas ____ million cubic feet ____	886,782	147,206	843,625	145,103	829,170	348,251	781,289	378,925

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
KANSAS—Continued								
Natural gas liquids:								
Natural gasoline ---- thousand 42-gallon barrels	6,630	$24,810	6,295	$25,062	6,434	$31,017	31,022	$190,811
LP gases ---- do	24,402	78,818	23,563	71,632	23,767	83,422		
Petroleum (crude) ---- do	61,691	490,984	59,106	561,508	58,714	557,783	57,496	574,960
Salt[7] ---- thousand short tons	1,367	27,007	1,446	31,214	1,310	35,291	1,430	41,154
Sand and gravel ---- do	11,687	13,388	10,866	13,467	[4]12,291	[4]14,940	[4]13,973	[4]23,299
Stone ---- do	[3]17,869	34,869	15,907	35,850	[3]16,348	[3]38,228	[3]17,229	[3]41,807
Value of items that cannot be disclosed: Clays (bentonite, 1976-77), diatomite (1974-76), gypsum, helium (crude), pumice (1974-75), salt (brine), sand and gravel (industrial, 1976-77), stone (dimension, 1976-77), and values indicated by W	XX	3,913	XX	6,418	XX	10,749	XX	22,627
Total	XX	889,398	XX	970,611	XX	1,213,848	XX	1,369,497
KENTUCKY								
Clays[2] ---- thousand short tons	848	1,477	778	1,483	754	2,395	716	2,500
Coal (bituminous) ---- do	137,197	2,340,961	143,613	2,499,295	143,972	2,848,690	146,262	2,928,678
Natural gas ---- million cubic feet	71,876	35,938	60,511	32,676	66,137	36,375	60,902	33,496
Petroleum (crude) ---- thousand 42-gallon barrels	7,837	68,340	7,556	84,520	7,483	85,454	6,581	85,659
Sand and gravel ---- thousand short tons	8,710	12,887	8,924	14,466	9,154	15,271	9,764	19,686
Stone ---- do	35,452	66,632	31,734	67,906	33,378	77,060	36,096	88,941
Zinc (recoverable content of ores, etc.) ---- short tons	--	--	41	32	59	44	--	--
Value of items that cannot be disclosed: Cement, clay (ball), fluorspar, lead (1975), lime, and natural gas liquids	XX	36,975	XX	38,481	XX	49,300	XX	58,900
Total	XX	2,563,210	XX	2,738,859	XX	3,114,589	XX	3,217,860
LOUISIANA								
Clays ---- thousand short tons	770	1,425	531	1,132	513	1,158	401	785
Lime ---- do	796	17,665	485	12,484	W	W	W	W
Natural gas ---- million cubic feet	7,753,631	2,380,365	7,090,645	2,999,179	7,006,596	3,223,034	7,215,006	5,068,295
Natural gas liquids:								
Natural gasoline and cycle products ---- thousand 42-gallon barrels	35,860	234,954	31,808	178,930	27,078	151,683	117,763	804,183
LP gases ---- do	108,439	423,996	103,714	392,039	91,701	375,057		

Petroleum (crude) do	737,324	4,811,772	650,840	4,611,879	606,501	4,556,761	562,905	4,689,122
Salt thousand short tons	13,543	76,960	12,166	77,116	13,491	91,952	13,201	96,878
Sand and gravel do	12,341	27,781	14,587	35,990	22,528	51,293	21,987	50,790
Stone do	[3]10,940	[3]24,046	10,489	38,260	9,685	28,127	9,710	26,920
Sulfur (Frasch process) thousand long tons	3,426	W	2,672	W	2,445	W	2,455	W
Value of items that cannot be disclosed: Cement, gypsum, stone (miscellaneous, 1974), and values indicated by W	XX	147,614	XX	166,266	XX	173,042	XX	174,912
Total	XX	8,146,578	XX	8,513,275	XX	8,652,107	XX	10,911,885
MAINE								
Clays thousand short tons	146	183	125	202	134	216	98	160
Copper short tons	1,522	2,353	2,024	2,599	1,766	2,459	1,337	1,787
Gem stones	NA	W	NA	W	NA	1,105	NA	W
Lead (recoverable content of ores, etc.) short tons	279	126	364	157	216	100	178	109
Peat thousand short tons	4	194	4	207	5	173	5	80
Sand and gravel do	8,755	10,673	9,875	11,403	[4]10,312	[4]13,950	10,487	19,023
Stone do	1,491	4,255	[3]1,253	[3]3,741	1,443	4,609	1,312	4,110
Zinc (recoverable content of ores, etc.) short tons	10,425	7,485	8,318	6,488	7,810	5,779	7,269	5,001
Value of items that cannot be disclosed: Cement, feldspar (1976-77), sand and gravel (industrial, 1976), silver (1974-76), stone (dimension, 1975), and values indicated by W	XX	11,079	XX	11,944	XX	11,973	XX	12,955
Total	XX	36,348	XX	36,741	XX	40,364	XX	43,225
MARYLAND								
Clays[2] thousand short tons	884	2,066	580	1,450	702	1,817	893	2,344
Coal (bituminous) do	2,337	48,630	2,606	50,502	2,830	61,974	3,036	53,676
Gem stones	NA	8	NA	W	NA	W	NA	W
Lime thousand short tons	23	527	15	434	16	494	W	W
Natural gas million cubic feet	133	32	93	25	75	24	82	32
Peat thousand short tons	3	45	2	39	2	W	3	W
Sand and gravel do	11,690	29,386	11,786	29,477	12,942	31,914	11,702	29,562
Stone do	18,072	47,630	14,796	43,110	15,709	47,669	16,766	50,680
Value of items that cannot be disclosed: Cement, clay (ball), talc and soapstone (1974), and items indicated by W	XX	44,556	XX	39,882	XX	41,026	XX	50,405
Total	XX	172,880	XX	164,919	XX	184,918	XX	186,699
MASSACHUSETTS								
Clays thousand short tons	218	379	124	228	126	238	149	275
Gem stones	NA	5	NA	W	NA	W	NA	W

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MASSACHUSETTS—Continued								
Lime thousand short tons	170	$4,972	152	$5,215	178	$6,354	W	W
Peat do	3	85	W	W	W	W	2	W
Sand and gravel do	17,334	26,565	13,281	24,556	16,084	29,666	16,639	$34,346
Stone do	8,103	30,103	7,170	28,681	7,937	33,502	8,093	35,357
Value of items that cannot be disclosed: Nonmetals and values indicated by W	XX	--	XX	166	XX	90	XX	7,290
Total	XX	62,109	XX	58,846	XX	69,850	XX	77,268
MICHIGAN								
Cement:								
Masonry thousand short tons	217	6,309	183	6,429	218	8,370	246	9,761
Portland do	5,903	140,513	4,573	131,324	4,931	145,381	5,582	166,803
Clays do	2,161	4,074	1,818	3,580	1,934	4,741	2,007	5,126
Copper (recoverable content of ores, etc.) short tons	67,012	103,601	73,690	94,618	43,707	60,840	42,375	56,613
Gem stones	NA	8	NA	8	NA	10	NA	12
Gypsum thousand short tons	1,482	7,258	1,224	5,936	1,837	9,842	1,924	8,778
Iron ore (usable) thousand long tons, gross weight	11,602	213,598	14,089	339,113	16,245	441,206	12,009	356,227
Lime thousand short tons	1,528	30,036	1,434	36,540	1,456	39,686	1,347	42,015
Magnesium compounds from seawater and brine (except for metal) short tons, MgO equivalent	503,281	53,302	W	W	W	W	W	W
Natural gas million cubic feet	69,133	34,843	102,113	64,740	119,262	106,739	129,954	131,254
Natural gas liquids:								
Natural gasoline thousand 42-gallon barrels	466	3,089	656	3,294	3,504	19,725	7,919	73,675
LP gases do	849	5,383	1,348	5,945	1,215	6,306		
Peat thousand short tons	244	3,811	245	3,206	^{r}280	^{r}3,397	226	3,917
Petroleum (crude) thousand 42-gallon barrels	18,021	154,746	24,420	262,352	30,421	329,637	32,965	362,722
Salt thousand short tons	4,445	62,055	4,020	68,353	4,219	79,740	3,939	78,808
Sand and gravel do	60,027	82,617	47,051	73,397	47,403	78,455	46,486	101,542
Silver (recoverable content of ores, etc.) thousand troy ounces	643	3,028	632	2,795	311	1,852	335	1,550
Stone thousand short tons	47,479	72,748	39,946	73,800	41,485	82,331	40,525	85,118
Value of items that cannot be disclosed: Bromine, calcium-chloride, iodine, and values indicated by W	XX	54,411	XX	116,223	XX	^{r}128,557	XX	138,626
Total	XX	1,035,430	XX	1,291,653	XX	^{r}1,546,315	XX	1,622,547

MINNESOTA								
Clays ---- thousand short tons--	W	W	W	W	W	W	[2]163	[2]276
Gem stones ----	NA	14	NA	14	NA	15	NA	15
Iron ore (usable)---- thousand long tons, gross weight--	59,422	949,678	49,167	1,015,272	47,874	1,137,733	30,245	782,627
Lime ---- short tons--	W	W	W	W	103,389	2,794	122,860	4,315
Manganiferous ore (5% to 35% Mn)---- short tons, gross weight --	225,560	W	108,749	W	202,271	W	166,440	W
Peat---- thousand short tons--	20	471	13	230	26	1,505	28	1,280
Sand and gravel---- do----	36,720	42,370	33,398	45,214	[4]33,486	[4]44,503	30,713	59,629
Stone ---- do----	8,301	22,041	6,854	23,302	7,567	25,767	7,865	25,124
Value of items that cannot be disclosed: Abrasive stones, cement (1974-75), clay (kaolin, 1977), sand and gravel (industrial, 1976), and values indicated by W ----	XX	11,792	XX	13,056	XX	5,713	XX	2,337
Total ----	XX	1,026,366	XX	1,097,088	XX	1,218,030	XX	875,603
MISSISSIPPI								
Clays ---- thousand short tons--	2,013	10,468	1,592	10,605	[2]1,487	[2]8,849	[2]1,483	[2]8,841
Lime ---- do----	70	1,393	53	1,060	57	1,248	49	1,079
Natural gas ---- million cubic feet--	78,787	23,242	74,345	36,875	70,762	50,241	82,995	60,589
Petroleum (crude) ---- thousand 42-gallon barrels--	50,779	309,753	46,614	310,346	46,072	328,957	43,022	352,844
Sand and gravel---- thousand short tons--	14,939	19,487	14,372	23,098	[4]12,033	[4]20,394	[4]13,353	[4]25,375
Stone ---- do----	1,719	2,572	1,629	2,730	1,762	2,968	2,176	3,933
Value of items that cannot be disclosed: Cement, clays (selected, 1976-77), magnesium compounds, natural gas liquids, and sand and gravel (industrial, 1976-77) ----	XX	24,240	XX	25,295	XX	37,205	XX	39,573
Total ----	XX	391,155	XX	410,009	XX	449,862	XX	492,234
MISSOURI								
Barite---- thousand short tons--	177	3,386	171	3,989	124	3,860	117	4,061
Cement:								
Masonry ---- do----	75	2,434	65	2,110	76	2,718	82	3,286
Portland ---- do----	4,229	106,985	3,962	116,260	4,353	142,976	4,654	155,945
Clays[2]---- do----	2,565	13,151	2,168	13,214	2,133	14,915	2,373	16,892
Coal (bituminous)---- do----	4,623	29,383	5,638	48,054	6,075	56,934	6,366	66,089
Copper (recoverable content of ores, etc.)---- short tons--	12,665	19,580	14,258	18,308	11,050	15,382	11,737	15,681

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MISSOURI—Continued								
Iron ore (usable) thousand long tons, gross weight	1,866	W	2,273	W	2,133	W	W	W
Lead (recoverable content of ores, etc.) short tons	562,097	$252,944	515,958	$221,862	500,991	$231,458	500,255	$307,156
Lime thousand short tons	1,901	36,369	1,606	40,630	1,731	49,907	1,723	51,529
Natural gas million cubic feet	33	10	30	10	29	10	20	8
Petroleum (crude) thousand 42-gallon barrels	56	W	57	W	61	W	W	W
Phosphate rock thousand short tons	35	W	35	W	W	W	W	W
Sand and gravel do	10,933	19,462	9,752	18,216	15,375	26,550	14,002	31,473
Silver (recoverable content of ores, etc.) thousand troy ounces	2,387	11,244	2,525	11,161	2,277	9,905	2,363	10,916
Stone thousand short tons	50,626	90,204	46,988	95,535	47,546	98,327	49,615	105,297
Zinc (recoverable content of ores, etc.) short tons	91,987	66,047	74,867	58,396	83,530	61,812	81,689	56,203
Value of items that cannot be disclosed: Asphalt (native), clays (selected, 1974-75, 1977), and values indicated by W	XX	39,850	XX	74,983	XX	70,406	XX	68,836
Total	XX	691,049	XX	722,728	XX	785,160	XX	893,372
MONTANA								
Antimony short tons	W	W	273	813	150	318	164	663
Clays thousand short tons	298	2,189	223	[2]1,878	192	W	224	3,557
Coal (bituminous and lignite) do	14,106	54,961	22,054	111,579	26,231	128,534	27,226	161,567
Copper (recoverable content of ores, etc.) short tons	131,131	202,728	87,959	112,940	91,111	126,827	86,203	115,167
Gem stones	NA	400	NA	400	NA	170	NA	100
Gold (recoverable content of ores, etc.) troy ounces	28,268	4,516	17,259	2,787	24,075	3,017	22,348	3,314
Iron ore (usable) thousand long tons, gross weight	30	W	18	W	18	W	W	W
Lead (recoverable content of ores, etc.) short tons	154	69	205	88	92	43	106	65
Lime thousand short tons	226	3,364	221	5,188	224	5,980	223	7,705
Natural gas million cubic feet	54,873	13,883	40,734	17,638	42,563	18,941	46,819	33,663
Peat thousand short tons	W	W	1	51	W	W	W	W
Petroleum (crude) thousand 42-gallon barrels	34,554	229,802	32,844	257,169	32,814	276,419	32,680	280,470
Pumice thousand short tons	--	--	--	--	5	8	5	7
Sand and gravel do	4,242	6,126	4,127	6,963	4,786	7,336	4,867	10,421
Silver (recoverable content of ores, etc.) thousand troy ounces	3,512	16,542	2,617	11,565	3,279	14,262	3,367	15,558
Stone thousand short tons	[3]3,115	[3]6,242	[3]3,130	[3]6,753	3,468	7,994	3,683	8,037
Talc do	W	W	W	W	225	2,960	226	2,947
Zinc (recoverable content of ores, etc.) short tons	136	98	110	86	64	47	79	54

Value of items that cannot be disclosed: Barite (1975-77), cement, clays (selected, 1975), fluorspar, gypsum, natural gas liquids, phosphate rock, stone (dimension, 1974-75), tungsten ore and concentrate, vermiculite, and values indicated by W	XX	33,881	XX	37,252	XX	43,433	XX	47,893
Total	XX	574,801	XX	573,150	XX	636,289	XX	691,188
NEBRASKA								
Clays thousand short tons	182	414	195	416	149	345	161	368
Gem stones	NA	11	NA	11	NA	11	NA	11
Lime thousand short tons	36	591	W	W	W	W	W	W
Natural gas million cubic feet	2,538	863	2,565	1,388	2,511	1,288	2,789	1,818
Petroleum (crude) thousand 42-gallon barrels	6,611	45,167	6,120	55,133	6,182	55,551	5,968	62,425
Sand and gravel thousand short tons	13,231	17,727	11,759	16,901	[4]14,230	[4]21,483	[4]16,848	[4]30,566
Stone do	4,630	10,364	4,242	10,322	4,101	11,054	4,128	12,974
Value of items that cannot be disclosed: Cement, natural gas liquids, sand and gravel (industrial, 1976-77), and values indicated by W	XX	23,497	XX	27,734	XX	33,633	XX	35,867
Total	XX	98,634	XX	111,905	XX	123,365	XX	144,029
NEVADA								
Barite thousand short tons	761	8,115	947	11,533	900	18,379	1,158	18,329
Clays do	39	218	[2]5	[2]136	[2]7	[2]174	[2]10	[2]158
Copper (recoverable content of ores, etc.) short tons	84,101	130,021	81,210	104,274	58,160	80,958	67,061	89,593
Gem stones	NA	400	NA	2,814	NA	1,300	NA	1,000
Gold (recoverable content of ores, etc.) troy ounces	298,754	47,723	332,814	53,746	287,962	36,087	324,003	48,053
Gypsum thousand short tons	843	2,959	558	2,375	792	3,884	1,242	6,834
Iron ore (usable) thousand long tons, gross weight	139	W	109	1,017	W	W	W	W
Lead (recoverable content of ores, etc.) short tons	1,785	803	2,976	1,280	582	269	743	456
Mercury 76-pound flasks	W	W	W	W	22,837	2,770	W	W
Petroleum (crude) thousand 42-gallon barrels	129	W	115	W	143	W	W	W
Pumice thousand short tons	W	W	W	W	388	763	656	1,154
Sand and gravel do	8,736	14,515	8,056	16,848	9,671	20,106	10,185	21,172
Silver (recoverable content of ores, etc.) thousand troy ounces	872	4,108	1,609	7,111	784	3,410	738	3,411
Stone thousand short tons	2,186	4,203	[3]1,829	[3]4,524	[3]1,904	[3]5,975	1,668	5,506
Tungsten ore and concentrate thousand pounds contained W	132	537	33	152	99	561	263	1,687
Zinc (recoverable content of ores, etc.) short tons	3,405	2,445	5,496	4,287	1,438	1,064	1,672	1,150
Value of items that cannot be disclosed: Antimony (1974), cement, clays (selected, 1975-77), diatomite, fluorspar, lime, lithium minerals, magnesite, molybdenum, perlite, salt, stone (dimension, 1975-76), talc, and values indicated by W	XX	41,829	XX	48,820	XX	57,983	XX	72,342
Total	XX	257,876	XX	258,917	XX	233,683	XX	270,845

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
NEW HAMPSHIRE								
Clays .... thousand short tons..	34	$55	W	W	W	W	W	W
Gem stones	NA	42	NA	W	NA	W	NA	W
Sand and gravel .... thousand short tons..	6,126	8,223	5,150	$9,077	[4]6,180	[4]$10,409	6,835	$13,888
Stone .... do....	590	5,371	1,519	7,938	742	7,032	792	6,686
Value of items that cannot be disclosed	--	--	XX	92	XX	138	XX	127
Total	XX	13,691	XX	17,107	XX	17,579	XX	20,701
NEW JERSEY								
Clays .... thousand short tons..	104	524	67	372	61	331	68	374
Gem stones	NA	16	NA	16	NA	17	NA	17
Peat .... thousand short tons..	31	603	29	686	22	568	30	769
Sand and gravel .... do....	17,924	47,292	13,012	39,640	12,420	39,439	9,697	29,327
Stone[3] .... do....	15,749	52,456	11,821	42,381	11,234	39,012	12,993	46,621
Zinc (recoverable content of ores, etc.) .... short tons..	32,848	23,585	31,105	24,262	33,767	24,987	33,464	23,024
Value of items that cannot be disclosed: Iron ore (1977), lime (1976-77), magnesium compounds, manganiferous residuum (1974-76), greensand marl, stone (dimension), and titanium concentrate	XX	16,272	XX	16,345	XX	15,532	XX	16,928
Total	XX	140,748	XX	123,702	XX	119,886	XX	117,060
NEW MEXICO								
Carbon dioxide .... million cubic feet..	W	W	569,352	60	856,548	80	W	W
Clays[2] .... thousand short tons..	55	317	44	61	56	116	69	113
Coal (bituminous) .... do....	9,392	W	8,785	W	9,760	W	11,083	87,952
Copper (recoverable content of ores, etc.) .... short tons..	196,585	303,920	146,263	187,802	172,360	239,925	164,698	220,037
Gem stones	NA	200	NA	200	NA	210	NA	170
Gold (recoverable content of ores) .... troy ounces..	15,427	2,464	15,049	2,430	15,198	1,905	13,560	2,011
Gypsum .... thousand short tons..	157	532	W	W	W	W	182	1,227
Helium (high-purity) .... million cubic feet..	--	--	W	W	W	W	W	W
Iron ore (usable) .... thousand long tons, gross weight..	6	135	W	W	--	--	--	--
Lead (recoverable content of ores, etc.) .... short tons..	2,364	1,064	1,931	830	W	W	W	W
Lime .... thousand short tons..	58	1,679	W	W	W	W	W	W
Manganiferous ore (5% to 35% Mn) .... short tons, gross weight..	47,348	W	49,976	W	45,362	W	29,120	W

Mica, scrap ---- thousand short tons	12	60	W	W	W	W	14	W
Natural gas ---- million cubic feet	1,244,779	390,861	1,217,430	493,059	1,230,976	695,501	1,202,973	974,408
Natural gas liquids:								
Natural gasoline and cycle products ---- thousand 42-gallon barrels	9,713	53,545	9,194	45,292	9,490	51,369	44,916	286,299
LP gases ---- do	30,271	120,781	30,214	122,065	32,654	180,577		
Peat ---- thousand short tons	4	111	--	--	--	--	2	55
Perlite ---- do	480	6,306	429	6,400	481	8,403	521	9,543
Petroleum (crude) ---- thousand 42-gallon barrels	98,695	712,578	95,063	788,073	92,130	814,419	87,223	805,065
Potassium salts ---- thousand short tons, K_2O equivalent	r2,061	r126,023	r1,749	r150,622	2,083	165,354	2,085	169,616
Pumice ---- thousand short tons	471	1,466	397	1,280	486	1,560	457	1,835
Salt ---- do	167	W	147	1,048	W	W	W	W
Sand and gravel ---- do	7,413	10,605	6,220	13,798	7,702	16,671	8,604	17,685
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	1,195	5,628	792	3,501	892	3,880	918	4,242
Stone ---- thousand short tons	[3]3,531	[3]8,359	2,197	4,683	1,935	4,394	1,967	4,892
Uranium (recoverable content of U_3O_8) ---- thousand pounds	9,971	104,693	10,393	127,829	11,880	191,271	13,167	260,037
Zinc (recoverable content of ores, etc.) ---- short tons	13,784	9,897	11,015	8,592	W	W	W	W
Value of items that cannot be disclosed: Cement, clay (fire), fluorspar (1974-75), molybdenum, stone (dimension, 1974), tin (1974-76), vanadium, and values indicated by W	XX	77,755	XX	104,614	XX	134,492	XX	65,617
Total	XX	r1,938,979	XX	r2,062,239	XX	2,510,127	XX	2,910,804
NEW YORK								
Clays[2] ---- thousand short tons	1,451	2,348	817	1,561	649	2,089	564	1,728
Gem stones	NA	16	NA	16	NA	15	NA	15
Gypsum ---- thousand short tons	364	2,942	W	W	W	W	W	W
Lead (recoverable content of ores, etc.) ---- short tons	3,076	1,384	3,027	1,302	3,196	1,476	2,778	1,706
Natural gas ---- million cubic feet	4,990	2,745	7,628	5,645	9,235	10,436	10,682	12,391
Peat ---- thousand short tons	18	181	22	377	32	684	39	569
Petroleum (crude) ---- thousand 42-gallon barrels	896	9,538	875	10,693	857	10,497	824	11,701
Salt ---- thousand short tons	6,464	57,705	5,978	57,344	6,495	66,441	6,452	72,623
Sand and gravel ---- do	30,614	46,652	22,158	44,064	27,881	56,132	29,197	57,570
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	64	304	56	248	49	214	56	260
Stone ---- thousand short tons	38,207	87,724	31,713	80,929	28,136	75,040	29,947	90,781
Zinc (recoverable content of ores, etc.) ---- short tons	93,077	66,829	76,612	59,757	73,671	54,517	70,839	48,737
Value of items that cannot be disclosed: Cement, clay (ball), emery, garnet (abrasive), iron ore, lime, mercury (1975), talc, titanium concentrate, wollastonite, and values indicated by W	XX	162,205	XX	135,792	XX	150,423	XX	163,726
Total	XX	440,573	XX	397,728	XX	427,964	XX	461,807

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NORTH CAROLINA								
Clays[2] thousand short tons	3,422	$4,648	2,582	$4,094	2,750	$4,677	3,022	$4,990
Feldspar short tons	650,684	11,147	468,401	7,905	515,477	11,549	509,976	11,410
Gem stones	NA	50	NA	50	NA	75	NA	75
Mica (scrap) thousand short tons	76	3,679	75	3,265	70	3,793	91	4,207
Sand and gravel do	12,784	20,844	8,169	15,610	9,049	18,287	9,690	21,269
Stone do	34,762	75,142	28,308	69,327	30,877	82,462	32,850	90,295
Talc and pyrophyllite short tons	110,978	993	95,575	1,605	113,754	1,087	W	W
Value of items that cannot be disclosed: Asbestos, cement, clay (kaolin), iron ore (1974), lithium minerals, mica (sheet), olivine, phosphate rock, and values indicated by W	XX	39,366	XX	51,479	XX	81,409	XX	99,265
Total	XX	155,869	XX	153,335	XX	203,339	XX	231,511
NORTH DAKOTA								
Coal (lignite) thousand short tons	7,463	16,351	8,515	27,010	11,102	41,507	12,028	48,495
Gem stones	NA	2	NA	2	NA	2	NA	2
Natural gas million cubic feet	31,206	6,210	24,786	5,701	31,470	10,699	29,173	10,303
Peat short tons	240	W	W	W	W	W	(5)	W
Petroleum (crude) thousand 42-gallon barrels	19,697	119,022	20,452	149,705	21,725	170,411	23,273	186,184
Sand and gravel thousand short tons	4,991	6,211	5,636	8,133	5,171	8,345	5,821	12,102
Stone do	35	115	30	153	--	--	--	--
Value of items that cannot be disclosed: Clays, lime, natural gas liquids, salt, and values indicated by W	XX	11,516	XX	10,800	XX	13,141	XX	14,980
Total	XX	159,427	XX	201,504	XX	244,105	XX	272,066
OHIO								
Cement:								
Masonry thousand short tons	158	5,227	136	4,576	155	7,288	186	8,875
Portland do	2,884	73,815	2,364	70,268	2,130	65,656	1,970	65,899
Clays do	4,325	13,488	3,451	11,822	4,288	14,704	3,568	12,835
Coal (bituminous) do	45,409	559,519	46,770	766,875	46,582	773,699	47,918	848,074
Gem stones	NA	8	NA	W	NA	W	NA	W

Lime	thousand short tons	4,171	93,695	3,482	95,136	3,788	114,299	3,199	111,100
Natural gas	million cubic feet	92,055	44,371	84,960	59,982	88,891	90,491	99,327	138,760
Peat	thousand short tons	5	74	4	99	3	121	15	107
Petroleum (crude)	thousand 42-gallon barrels	9,088	89,348	9,578	113,917	9,994	117,655	10,359	136,281
Salt	thousand short tons	5,029	49,089	5,083	54,651	5,052	66,332	3,701	63,485
Sand and gravel	do.	41,353	68,258	37,195	68,552	38,876	76,730	46,521	100,736
Stone	do.	[3]51,709	[3]105,098	46,303	108,580	42,699	106,996	45,001	119,966
Value of items that cannot be disclosed: Abrasive stone, gypsum, stone (dimension, 1974), and values indicated by W		XX	5,680	XX	1,996	XX	1,925	XX	1,336
Total		XX	1,107,670	XX	1,356,454	XX	1,435,896	XX	1,607,454
OKLAHOMA									
Clays	thousand short tons	1,289	2,105	995	1,701	1,155	1,678	1,016	1,687
Coal (bituminous)	do.	2,356	24,759	2,872	47,946	3,635	58,102	5,978	105,433
Gypsum	do.	1,225	5,622	1,028	4,835	1,120	5,822	1,238	6,959
Helium:									
High-purity	million cubic feet	169	5,915	224	7,411	r241	r7,610	389	11,507
Crude	do.	134	1,608	148	1,776	r183	r2,200	W	W
Lead (recoverable content of ores, etc.)	short tons	W	W	--	--	W	W	W	W
Natural gas	million cubic feet	1,638,942	458,904	1,605,410	513,731	1,726,513	866,710	1,769,519	1,397,920
Natural gas liquids:									
Natural gasoline and cycle products	thousand 42-gallon barrels	12,581	84,638	10,835	63,383	10,894	74,416	41,893	271,214
LP gases	do.	31,231	166,461	29,640	140,197	31,620	179,602		
Petroleum (crude)	do.	177,785	1,277,076	163,123	1,389,164	161,426	1,484,297	156,382	1,560,240
Pumice	thousand short tons	W	W	1	W	1	W	1	W
Sand and gravel	do.	8,708	13,772	9,591	16,749	10,037	19,050	11,669	26,827
Stone	do.	22,228	36,599	20,111	36,840	19,635	37,339	23,332	47,443
Zinc (recoverable content of ores, etc.)	short tons	W	W	--	--	W	W	W	W
Value of items that cannot be disclosed: Cement, copper (1974-75), feldspar (1974, 1976-77), iodine (1977) lime, salt, silver (1974-75), tripoli, and values indicated by W		XX	45,142	XX	43,362	XX	53,100	XX	68,217
Total		XX	2,122,601	XX	2,267,095	XX	r2,789,926	XX	3,497,447
OREGON									
Clays	thousand short tons	140	243	120	214	147	315	119	193
Copper	short tons	W	W	W	W	--	--	6	7
Gem stones		NA	500	NA	500	NA	525	NA	520
Gold (recoverable content of ores, etc.)	troy ounces	W	W	W	W	28	4	675	100
Lead (recoverable content of ores, etc.)	short tons	W	W	W	W	--	--	--	--
Lime	thousand short tons	98	2,818	96	3,281	W	W	W	W

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
OREGON—Continued								
Nickel (content of ore and concentrate) short tons	16,618	W	16,987	W	16,469	W	14,347	W
Pumice thousand short tons	915	$1,887	1,470	$3,937	1,125	$2,311	1,083	$2,429
Sand and gravel do	18,558	30,948	16,527	29,596	[4]17,554	[4]33,473	15,833	33,127
Silver (recoverable content of ores, etc.) thousand troy ounces	9	42	W	W	--	--	7	33
Stone thousand short tons	23,353	43,406	21,275	40,321	20,349	42,686	17,600	39,400
Value of items that cannot be disclosed: Cement, diatomite, emery (1975), sand and gravel (industrial, 1976), talc and soapstone, tungsten (1976-77), and values indicated by W	XX	24,076	XX	28,155	XX	33,252	XX	33,323
Total	XX	103,920	XX	106,004	XX	112,566	XX	109,132
PENNSYLVANIA								
Cement:								
Masonry thousand short tons	404	14,642	357	14,640	379	16,903	411	19,927
Portland do	7,448	191,594	5,815	168,220	5,989	185,170	6,162	196,443
Clays[2] do	2,732	16,496	1,945	13,672	2,291	16,037	2,304	13,075
Coal:								
Anthracite do	6,617	144,695	6,203	198,481	6,228	209,234	5,861	205,138
Bituminous do	80,462	1,637,394	84,137	2,111,009	85,777	2,173,009	84,639	2,166,685
Copper (recoverable content of ores, etc.) short tons	--	--	--	--	W	W	W	W
Gem stones	NA	9	NA	9	NA	9	NA	10
Lime thousand short tons	2,080	50,147	1,940	60,047	2,069	68,356	2,007	72,591
Mica, scrap do	--	--	W	W	W	W	1	W
Natural gas million cubic feet	82,637	36,360	84,676	57,156	89,386	61,229	91,717	73,374
Peat thousand short tons	30	515	27	488	W	W	16	353
Petroleum (crude) thousand 42-gallon barrels	3,478	36,220	3,264	39,647	3,019	36,700	2,715	38,810
Sand and gravel thousand short tons	18,071	45,181	17,401	48,742	19,038	55,611	18,846	52,578
Stone do	73,092	159,615	60,177	149,670	63,607	165,889	63,588	169,014
Zinc (recoverable content of ores, etc.) short tons	20,288	14,567	21,090	16,450	22,280	16,487	22,825	15,703
Value of items that cannot be disclosed: Abrasives (1977), clay (kaolin), iron ore, natural gas liquids, tripoli, and values indicated by W	XX	26,993	XX	29,607	XX	32,716	XX	20,263
Total	XX	2,374,428	XX	2,907,838	XX	3,037,350	XX	3,043,964

RHODE ISLAND								
Sand and gravel thousand short tons	2,784	4,605	2,910	5,070	2,914	4,805	2,872	5,059
Stone do	W	W	293	1,125	305	1,295	274	1,238
Value of items that cannot be disclosed: Other nonmetals and values indicated by W	XX	1,377	XX	3	XX	300	XX	2
Total	XX	5,982	XX	6,198	XX	6,400	XX	6,299
SOUTH CAROLINA								
Clays thousand short tons	[2]2,297	[2]13,765	[2]1,698	[2]12,828	2,270	17,288	[2]2,172	[2]18,705
Gem stones	NA	5	NA	5	NA	4	NA	4
Mica (scrap) thousand short tons	W	252	7	318	W	W	43	589
Peat do	18	W	18	W	15	W	16	W
Sand and gravel do	7,380	13,054	7,363	14,128	7,887	17,154	7,766	19,281
Stone do	[3]12,242	[3]21,719	13,836	30,082	13,027	30,690	14,785	36,670
Value of items that cannot be disclosed: Cement, clay (fuller's earth, 1974-75, 1977), manganiferous ore (1975-77), stone (crushed, 1974), vermiculite, and values indicated by W	XX	56,376	XX	58,107	XX	60,397	XX	68,952
Total	XX	105,171	XX	115,468	XX	125,533	XX	144,201
SOUTH DAKOTA								
Clays[2] thousand short tons	190	202	187	185	124	137	197	233
Gem stones	NA	42	NA	42	NA	44	NA	40
Gold (recoverable content of ores, etc.) troy ounces	343,723	54,906	304,935	49,244	318,511	39,916	304,846	45,212
Gypsum thousand short tons	32	135	23	60	W	W	W	W
Lime do	94	2,059	W	W	W	W	W	W
Mica (scrap) do	W	W	W	W	--	--	56	5
Petroleum (crude) thousand 42-gallon barrels	494	3,283	472	5,996	447	5,519	632	7,584
Sand and gravel thousand short tons	9,028	9,720	6,481	8,668	5,763	8,057	6,043	9,815
Silver (recoverable content of ores, etc.) thousand troy ounces	62	294	68	299	58	253	69	317
Stone thousand short tons	2,968	14,231	2,647	15,350	3,241	17,240	3,412	18,881
Value of items that cannot be disclosed: Beryllium concentrate (1975-77), cement, clay (bentonite), feldspar, iron ore (1974-76), natural gas liquids, and values indicated by W	XX	17,938	XX	21,977	XX	30,364	XX	28,653
Total	XX	102,810	XX	101,821	XX	101,530	XX	110,740

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
TENNESSEE								
Barite thousand short tons	W	W	13	$260	W	W	W	W
Cement:								
Masonry do	154	$4,706	138	4,778	175	$6,476	195	$7,878
Portland do	1,525	43,339	1,136	37,866	1,256	43,495	1,522	52,894
Clays[2] do	1,638	9,776	1,310	9,008	1,530	11,578	1,578	13,968
Coal (bituminous) do	7,541	135,874	8,206	140,293	9,283	151,372	9,433	206,226
Copper (recoverable content of ores, etc.) short tons	6,304	9,745	10,041	12,893	11,131	15,494	6,187	8,266
Gold (recoverable content of ores, etc.) troy ounces	18	3	W	W	W	W	13	2
Lime thousand short tons	136	3,449	106	3,735	W	W	W	W
Natural gas million cubic feet	17	6	27	12	47	24	263	195
Petroleum (crude) thousand 42-gallon barrels	769	7,256	682	7,849	598	8,203	820	11,271
Phosphate rock thousand short tons	2,411	18,465	2,291	28,803	1,801	[r]14,541	1,926	14,253
Sand and gravel do	10,702	19,476	10,909	22,102	11,096	25,129	12,773	29,197
Silver (recoverable content of ores, etc.) thousand troy ounces	20	94	54	238	78	339	60	278
Stone thousand short tons	41,720	75,547	38,439	81,187	37,600	86,156	41,911	100,137
Zinc (recoverable content of ores, etc.) short tons	85,671	61,512	83,293	64,968	82,512	61,059	90,438	62,221
Value of items that cannot be disclosed: Clays (selected), pyrites, and values indicated by W	XX	6,360	XX	8,526	XX	15,862	XX	14,585
Total	XX	395,608	XX	422,518	XX	[r]439,728	XX	521,371
TEXAS								
Cement:								
Masonry thousand short tons	195	6,438	181	7,089	213	10,596	254	13,095
Portland do	7,739	207,706	7,195	224,804	7,388	271,066	8,482	331,758
Clays do	5,315	13,677	4,248	13,411	[2]3,706	[2]8,847	[2]3,682	[2]11,465
Coal (lignite) do	7,684	W	11,002	W	14,063	W	W	W
Gem stones	NA	160	NA	160	NA	168	NA	160
Gypsum thousand short tons	1,365	5,276	1,094	4,277	1,531	6,322	1,718	8,837
Helium (crude) million cubic feet	35	420	36	432	12	[r]149	W	W
Iron ore thousand long tons	W	W	601	W	566	W	W	W
Lime thousand short tons	1,835	39,644	1,735	46,179	1,455	43,983	1,612	49,965
Natural gas million cubic feet	8,170,798	2,541,118	7,485,764	3,885,112	7,191,859	5,163,755	7,051,027	6,367,077

Natural gas liquids:								
Natural gasoline and cycle products — thousand 42-gallon barrels	88,316	629,529	78,835	479,700	77,578	560,831	283,772	2,009,366
LP gases — do	213,756	1,004,653	212,635	965,363	209,514	1,223,562		
Petroleum (crude) — do	1,262,126	8,773,003	1,221,929	9,336,570	1,189,523	10,217,702	1,137,880	9,986,002
Salt — thousand short tons	11,379	51,296	8,560	42,119	9,718	48,875	10,941	53,264
Sand and gravel — do	42,466	81,364	38,649	87,106	47,848	103,217	55,495	133,420
Stone — do	[3]63,074	[3]109,758	57,985	106,554	54,856	101,652	65,474	126,706
Sulfur (Frasch process) — thousand long tons	4,473	W	3,406	W	3,415	W	3,480	W
Talc and soapstone — short tons	188,262	1,310	129,626	795	199,663	1,071	233,024	2,191
Value of items that cannot be disclosed: Asphalt (native), clays (selected, 1976-77), fluorspar, graphite, magnesium chloride (for metal), magnesium compounds (except for metal), sodium sulfate, stone (dimension, 1974), uranium, vermiculite (1977), and values indicated by W	XX	245,792	XX	325,701	XX	381,413	XX	426,325
Total	XX	13,711,144	XX	15,525,372	XX	[r]18,143,209	XX	19,519,631
UTAH								
Carbon dioxide, natural — thousand cubic feet	93,571	6	108,941	8	21,875	2	W	W
Clays — thousand short tons	232	953	[2]220	[2]548	[2]206	[2]531	[2]244	[2]713
Coal (bituminous) — do	5,858	71,699	6,961	138,134	7,967	182,712	8,581	174,342
Copper (recoverable content of ores, etc.) — short tons	230,593	356,497	177,155	227,467	185,458	258,157	194,130	259,357
Fluorspar — do	2,967	98	9,542	389	W	W	--	--
Gem stones	NA	100	NA	100	NA	105	NA	100
Gold (recoverable content of ores, etc.) — troy ounces	254,909	40,719	189,620	30,622	187,318	23,475	210,501	31,219
Gypsum — thousand short tons	248	1,076	247	1,457	270	1,657	324	2,510
Iron ore (usable) — thousand long tons, gross weight	1,808	14,016	1,334	10,399	W	W	1,932	19,780
Lead (recoverable content of ores, etc.) — short tons	10,510	4,729	12,679	5,452	16,297	7,529	10,746	6,598
Lime — thousand short tons	176	4,911	161	4,540	202	6,855	209	8,274
Natural gas — million cubic feet	50,522	20,815	55,354	26,570	57,416	28,995	60,696	37,146
Petroleum (crude) — thousand 42-gallon barrels	39,363	279,858	42,301	348,131	34,304	318,911	33,113	308,872
Pumice — thousand short tons	15	19	17	23	164	264	W	W
Salt — do	771	7,321	631	7,717	705	10,090	843	10,831
Sand and gravel — do	11,578	12,985	10,159	14,342	[4]10,547	[4]13,442	[4]11,895	[4]18,662
Silver (recoverable content of ores, etc.) — thousand troy ounces	3,208	15,109	2,822	12,472	3,134	13,633	3,288	15,169
Stone — thousand short tons	2,869	6,410	2,486	6,167	2,751	7,009	2,771	7,310

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
UTAH—Continued								
Tungsten ore and concentrate ____thousand pounds contained W__	W	W	W	W	W	W	27	$219
Zinc (recoverable content of ores, etc.) __________short tons__	12,619	$9,060	19,640	$15,319	22,481	$16,636	17,759	12,218
Value of items that cannot be disclosed: Asphalt (gilsonite), beryl concentrate, cement, clays (kaolin, 1975-77, fuller's earth, 1977), magnesium chloride (1974-75), magnesium compounds, molybdenum, natural gas liquids, phosphate rock, potassium salts, sand and gravel (industrial, 1976-77), sodium sulfate, uranium, vanadium, and values indicated by W	XX	105,664	XX	116,550	XX	153,978	XX	172,019
Total ______________________	XX	952,045	XX	966,407	XX	1,043,981	XX	1,085,339
VERMONT								
Peat ____________ thousand short tons__	([5])	4	([5])	W	--	--	--	--
Sand and gravel ________________do____	2,394	3,588	2,356	3,693	[4]2,379	[4]3,758	3,405	5,837
Stone ____________________do____	1,932	21,630	1,224	15,718	1,978	22,443	2,244	27,196
Talc ____________________short tons__	W	W	230,973	1,918	252,371	1,685	310,038	2,006
Value of items that cannot be disclosed: Asbestos, other nonmetals, and values indicated by W ______________	XX	8,723	XX	7,450	XX	7,211	XX	6,415
Total ______________________	XX	33,945	XX	28,779	XX	35,097	XX	41,454
VIRGINIA								
Clays ____________ thousand short tons__	1,957	2,614	819	1,152	862	1,210	890	1,294
Coal (bituminous) ______________do____	34,326	856,099	35,510	1,081,587	39,996	964,669	37,624	1,115,438
Gem stones ______________________	NA	13	NA	13	NA	12	NA	12
Lead (recoverable content of ores, etc.) ______short tons__	3,106	1,398	2,551	1,097	1,946	899	2,203	1,352
Lime ____________ thousand short tons__	895	18,929	705	20,192	878	25,993	846	28,767
Natural gas ____________ million cubic feet__	7,096	3,619	6,723	3,462	6,937	7,908	8,220	10,357
Petroleum (crude) ______ thousand 42-gallon barrels__	3	W	3	W	3	W	W	W
Sand and gravel ________ thousand short tons__	14,314	29,270	9,895	24,776	[4]10,191	[4]23,089	[4]10,447	[4]24,605
Stone ____________________do____	44,176	95,988	35,384	84,204	36,132	91,723	41,717	111,601
Zinc (recoverable content of ores, etc.) ______short tons__	17,195	12,346	15,151	11,818	11,214	8,319	13,272	9,131
Value of items that cannot be disclosed: Aplite, cement, gypsum, kyanite, sand and gravel (industrial, 1976-77), silver (1975-77), soapstone, and values indicated by W ______________	XX	36,293	XX	33,673	XX	36,823	XX	39,129
Total ______________________	XX	1,056,569	XX	1,261,974	XX	1,160,645	XX	1,341,686

WASHINGTON								
Cement:								
Masonry ---- thousand short tons	6	193	5	209	6	334	W	W
Portland ---- do	1,377	36,347	1,147	40,666	1,238	48,669	1,462	65,281
Clays[2] ---- do	269	698	290	778	381	1,141	309	1,091
Coal (bituminous) ---- do	3,913	W	3,743	W	4,109	W	5,057	57,042
Gem stones	NA	160	NA	160	NA	168	NA	160
Gold ---- troy ounces	W	W	W	W	W	W	24,006	3,560
Lead (recoverable content of ores, etc.) ---- short tons	1,299	585	W	W	W	W	1,201	738
Peat ---- thousand short tons	14	85	13	98	14	103	12	117
Pumice ---- do	(5)	1	--	--	--	--	W	W
Sand and gravel ---- do	22,842	35,030	19,069	32,990	19,813	36,017	18,505	39,124
Silver ---- thousand troy ounces	W	W	W	W	W	W	121	557
Stone ---- thousand short tons	15,095	24,483	7,920	18,754	10,223	24,091	12,244	28,596
Zinc (recoverable content of ores, etc.) ---- short tons	6,909	4,960	W	W	W	W	5,572	3,834
Values of items that cannot be disclosed: Clay (fire), copper, diatomite, gypsum, lime, olivine, talc, tungsten, uranium, and values indicated by W	XX	41,388	XX	64,850	XX	76,699	XX	16,024
Total	XX	143,930	XX	158,505	XX	187,222	XX	216,124
WEST VIRGINIA								
Clays[2] ---- thousand short tons	339	520	278	439	275	463	389	599
Coal (bituminous) ---- do	102,462	2,218,418	109,283	3,206,951	108,834	3,278,180	95,433	2,961,186
Gem stones	NA	2	NA	2	NA	2	NA	2
Natural gas ---- million cubic feet	202,306	66,356	154,484	57,005	153,322	87,394	152,767	93,188
Petroleum (crude) ---- thousand 42-gallon barrels	2,665	27,058	2,479	29,712	2,519	30,227	2,518	35,175
Salt ---- thousand short tons	1,201	6,296	972	4,671	1,118	W	1,048	W
Sand and gravel ---- do	5,382	16,018	5,068	17,872	[4]4,337	[4]11,006	[4]3,891	[4]10,402
Stone ---- do	10,954	22,308	[3]10,583	[3]24,333	[3]9,717	[3]24,133	[3]10,495	[3]28,022
Value of items that cannot be disclosed: Cement, clays (fire), lime, natural gas liquids, sand and gravel (industrial, 1976-77), stone (dimension, 1975-77), and values indicated by W	XX	46,201	XX	49,226	XX	66,596	XX	79,494
Total	XX	2,403,177	XX	3,390,211	XX	3,498,001	XX	3,208,068

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State —Continued

Mineral	1974		1975		1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
WISCONSIN								
Clays ---- thousand short tons	2	$4	2	$4	W	W	W	W
Gem stones	NA	1	NA	1	NA	$1	NA	$1
Iron ore (usable) ---- thousand long tons, gross weight	899	W	791	W	664	W	668	W
Lead (recoverable content of ores, etc.) ---- short tons	1,285	578	W	W	W	W	W	W
Lime ---- thousand short tons	311	6,764	296	8,604	325	10,058	378	13,521
Peat ---- do	W	W	11	502	11	W	14	196
Sand and gravel ---- do	28,850	34,577	30,057	40,580	30,879	42,001	29,025	50,210
Stone ---- do	22,443	40,912	20,566	40,156	20,739	41,338	22,314	46,918
Zinc (recoverable content of ores, etc.) ---- short tons	8,737	6,273	W	W	W	W	W	W
Value of items that cannot be disclosed: Abrasive stones, cement, copper (1974-75), silver (1974-75), and values indicated by W	XX	25,654	XX	42,413	XX	39,055	XX	39,282
Total	XX	114,763	XX	132,260	XX	132,453	XX	150,128
WYOMING								
Clays ---- thousand short tons	2,511	29,339	2,582	36,046	2,697	40,015	2,966	48,369
Coal (bituminous) ---- do	20,703	103,915	23,804	160,447	30,836	215,936	46,028	377,990
Gem stones	NA	140	NA	140	NA	147	NA	200
Gypsum ---- thousand short tons	315	960	271	902	317	1,280	356	2,571
Iron ore (usable) ---- thousand long tons, gross weight	2,105	W	2,039	26,792	2,139	29,461	W	W
Lime ---- thousand short tons	29	464	W	W	W	W	W	W
Natural gas ---- million cubic feet	326,657	80,031	316,123	106,533	328,768	134,795	330,180	211,315
Natural gas liquids:								
Natural gasoline ---- thousand 42-gallon barrels	2,933	18,577	2,909	17,694	3,044	19,866	10,148	64,970
LP gases ---- do	6,804	31,707	6,061	29,578	6,681	35,677		
Petroleum (crude) ---- do	139,997	914,360	135,943	983,785	134,149	971,235	136,472	1,039,948
Sand and gravel ---- thousand short tons	5,532	9,508	4,328	10,746	5,470	10,782	5,084	11,026
Stone ---- do	2,384	[3]5,989	2,882	7,618	2,757	7,630	[3]2,434	[3]7,585
Uranium (recoverable content of U_3O_8) ---- thousand pounds	7,449	78,213	6,862	84,406	8,064	129,823	9,857	194,682

Value of items that cannot be disclosed: Cement, feldspar, phosphate rock, sodium carbonate, stone (dimension, 1974, 1977), and values indicated by W	XX	163,997	XX	179,751	XX	254,952	XX	372,693
Total	XX	1,437,200	XX	1,644,438	XX	1,851,599	XX	2,331,349

[r] Revised. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain clays, included with "Value of items that cannot be disclosed."
[3] Excludes certain stones, included with "Value of items that cannot be disclosed."
[4] Excludes industrial sand and gravel, included with "Value of items that cannot be disclosed."
[5] Less than 1/2 unit.
[6] Total of items listed.
[7] Excludes salt in brine, included with "Value of items that cannot be disclosed."

Note: Beginning with 1977, data on mineral fuels supplied by the Department of Energy.

Table 7.—Mineral production[1] in the islands administered by the United States

(Thousand short tons and thousand dollars)

Area and mineral	1974		1975		1976		1977	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
American Samoa:								
Pumice	27	183	15	15	47	30	1	10
Stone	50	122	34	147	30	156	6	31
Total	XX	305	XX	162	XX	186	XX	41
Guam: Stone	798	1,444	781	1,837	457	1,438	577	1,897
Virgin Islands: Stone	638	3,869	253	1,813	279	2,050	262	2,076

XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 8.—Mineral production[1] in the Commonwealth of Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1974		1975		1976		1977	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cement	1,881	70,277	1,582	60,968	1,558	66,150	1,367	67,775
Clays	291	332	341	440	W	W	272	387
Lime	39	2,923	28	2,231	28	2,513	40	3,007
Salt	29	624	27	639	27	639	27	639
Sand and gravel	NA	NA	NA	NA	NA	NA	[e]12,000	[e]21,000
Stone	14,362	41,640	13,595	47,515	13,404	47,124	12,187	44,281
Total	XX	[2]115,796	XX	[2]111,793	XX	[2]116,426	XX	137,089

[e] Estimate. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Total does not include value of items withheld or not available.

Table 9.—U.S. exports of principal minerals and products

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS				
Aluminum:				
Ingots, slabs, crude short tons	152,366	$118,644	97,771	$94,498
Scrap do	108,958	63,245	101,663	64,060
Plates, sheets, bars, etc do	203,843	261,759	190,118	284,199
Castings and forgings do	5,611	21,232	6,895	27,432
Aluminum sulfate do	50,758	1,569	12,019	900
Other aluminum compounds do	911,460	166,084	33,623	17,575
Antimony, metals and alloys, crude do	341	853	742	1,219
Bauxite, including bauxite concentrates thousand long tons	15	1,297	25	2,344
Beryllium pounds	114,143	1,756	160,505	1,911
Bismuth, metals and alloys do	[1]68,488	[1]514	95,334	637
Cadmium thousand pounds	504	713	236	316
Calcium:				
Carbonate short tons	3,411	735	14,887	4,053
Chloride do	33,533	2,578	39,552	3,383
Dicalcium phosphate do	32,302	7,612	53,309	9,550
Chrome:				
Ore and concentrates:				
Exports thousand short tons	124	5,609	187	10,105
Reexports do	85	5,475	61	4,913
Ferrochrome do	14	8,785	12	7,268
Cobalt thousand pounds	3,892	12,427	2,585	11,149
Columbium metals, alloys, other forms do	67	778	75	1,408
Copper:				
Ore, concentrate, composition metal, and unrefined (copper content) short tons	22,689	19,769	35,953	24,708
Scrap do	37,473	37,079	37,892	36,006
Refined copper and semimanufactures do	176,877	313,377	146,004	331,265
Other copper manufactures do	4,923	8,435	6,920	10,923
Copper sulfate or blue vitriol do	2,071	2,935	2,616	3,370
Copper-base alloys do	110,665	177,270	112,097	167,306
Ferroalloys:				
Ferrosilicon do	12,416	7,449	10,548	6,035
Ferrophosphorus do	1,636	153	2,381	297
Ferroalloys, n.s.p.f do	6,687	13,121	7,982	8,558
Spiegeleisen do	5,471	901	40	13
Gold:				
Ore and base bullion troy ounces	337,517	41,624	395,760	57,477
Bullion, refined do	3,193,248	333,424	8,275,095	1,055,234
Iron ore thousand long tons	2,913	82,192	2,143	62,756
Iron and steel:				
Pig iron short tons	57,480	5,408	51,357	4,266
Iron and steel products (major):				
Semimanufactures do	1,856,573	592,126	1,444,572	525,592
Manufactures and steel mill products do	1,814,776	1,870,281	1,653,428	1,758,832
Iron and steel scrap:				
Ferrous scrap, including rerolling materials thousand short tons	8,168	636,758	6,211	415,345
Slag short tons	38,718	1,264	33,376	961
Lead and zinc ores and concentrates do	148,787	28,892	128,056	28,753
Lead:				
Pigs, bars, anodes, sheets, etc do	5,877	5,320	9,845	8,425
Scrap do	46,883	11,539	85,411	22,442
Magnesium, metal and alloys, scrap, semimanufactured forms, n.e.c do	13,444	26,902	28,061	51,848
Manganese:				
Ore and concentrate do	127,971	7,510	138,250	9,221
Ferromanganese do	6,789	3,462	6,051	3,391
Metal do	4,654	3,434	2,953	3,208
Mercury:				
Exports 76-pound flasks	501	306	852	287
Reexports do	12	6	101	36
Molybdenum:				
Ore and concentrates (molybdenum content) thousand pounds	62,474	183,536	65,666	245,777
Metals and alloys, crude and scrap do	223	390	332	851
Wire do	343	3,672	475	6,047
Semimanufactured forms, n.e.c do	184	1,584	164	2,441
Powder do	25	136	151	759
Ferromolybdenum do	3,596	9,447	1,595	4,863
Nickel:				
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc short tons	[r]37,748	[r]141,324	29,958	132,093
Catalysts do	4,442	16,282	4,064	15,674
Nickel-chrome electric resistance wire do	769	5,253	764	6,006
Semifabricated forms, n.e.c do	4,207	30,736	4,626	36,807

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS —Continued				
Platinum:				
Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, other forms, including scrap troy ounces	325,805	$37,868	289,307	$33,076
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap) do	186,602	14,885	137,324	13,414
Rare earths:				
Ferrocerium and alloys short tons	60	335	260	1,043
Compounds pounds	1,465,364	2,720	1,931,245	6,038
Selenium thousand pounds	118	2,131	68	1,145
Silicon:				
Ferrosilicon short tons	12,416	7,449	10,548	6,035
Silicon carbide, crude and in grains do	10	6,174	11	7,062
Silver:				
Ore, concentrates, waste, sweepings thousand troy ounces	7,000	28,849	13,400	45,480
Bullion, refined do	7,596	32,586	8,994	39,165
Tantalum:				
Ore, metal, other forms thousand pounds	^{r}426	6,711	587	12,874
Powder do	^{r}219	7,982	234	9,380
Tin:				
Ingots, pigs, bars, etc.:				
Exports metric tons	540	2,998	545	5,176
Reexports do	1,798	13,967	4,935	50,175
Tin scrap and other tin-bearing material except tinplate scrap do	6,927	7,391	NA	9,328
Titanium:				
Ore and concentrate short tons	4,802	477	22,679	743
Sponge (including iodide titanium and scrap) do	6,144	8,547	3,394	5,643
Intermediate mill shapes and mill products, n.e.c. do	1,065	15,039	1,050	14,254
Pigments and oxides do	20,580	16,229	16,336	12,628
Tungsten:				
Ores and concentrates:				
Exports thousand pounds	1,729	11,189	1,283	11,400
Reexports do	887	1,903	NA	NA
Ferrotungsten do	--	--	2	31
Uranium:				
Ores and concentrates (U_3O_8 content) pounds	1,495,130	24,432	1,929,467	65,913
Metal do	7,108	146	NA	NA
Compounds do	369,036	7,232	245,570	2,848
Isotopes (stable) and their compounds	NA	2,103	NA	4,627
Radioactive materials thousand curies	31,474,488	25,905	33,605,884	32,862
Special nuclear materials	NA	426,423	NA	501,590
Vanadium:				
Ore and concentrate, pentoxide, etc. (vanadium content) pounds	197,035	742	384,000	1,959
Ferrovanadium do	2,421,776	9,180	1,316,000	4,954
Zinc:				
Slabs, pigs, or blocks short tons	3,513	2,306	237	210
Sheets, plates, strips, other forms n.e.c do	2,271	2,817	2,681	3,144
Waste, scrap, and dust (zinc content) do	8,945	3,535	9,230	3,698
Semifabricated forms, n.e.c do	9,320	6,076	6,147	4,618
Zirconium:				
Ore and concentrate thousand pounds	18,856	2,784	28,727	2,242
Oxide do	5,325	6,104	3,704	3,846
Metals, alloys, other forms do	2,304	43,809	1,965	36,828
NONMETALS				
Abrasives:				
Dust and powder of precious or semiprecious stones, including diamond dust and powder thousand carats	14,155	35,450	17,272	42,714
Crushing bort do	77	182	6	42
Industrial diamonds do	639	3,677	376	1,854
Diamond grinding wheels do	730	4,911	797	5,900
Other natural and artificial metallic abrasives and products	NA	68,979	NA	71,069
Asbestos:				
Exports:				
Unmanufactured short tons	46,317	12,640	37,390	11,701
Products do	NA	60,276	NA	78,350
Reexports:				
Unmanufactured do	606	151	247	30
Products do	NA	296	NA	472

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS —Continued				
Barite:				
Natural barium sulfate and carbonate, short tons	41,063	$2,871	49,551	$3,426
Lithopone, do	779	937	435	698
Boron:				
Boric acid, do	36,492	12,363	35,992	12,931
Sodium borates, refined, do	211,362	49,156	265,470	64,634
Cement, do	466,055	26,601	238,906	23,740
Clays:				
Kaolin or china clay, thousand short tons	839	57,649	952	71,907
Fire clay, do	296	12,895	307	11,632
Other clays, do	1,351	81,409	1,302	77,251
Diatomite, do	149	16,932	152	18,876
Feldspar, leucite, nepheline syenite, thousand pounds	12,289	352	12,404	394
Fluorspar, short tons	4,923	764	6,642	975
Gem stones:				
Diamonds, thousand carats	313	306,098	316	335,991
Pearls	NA	581	NA	545
Other	NA	30,896	NA	24,050
Graphite, short tons	[r]12,236	[r]2,388	13,783	2,662
Gypsum:				
Crude, crushed or calcined, thousand short tons	284	6,739	143	6,090
Manufactures, n.e.c	NA	25,855	NA	9,613
Helium, million cubic feet	174	8,790	168	10,561
Lithium hydroxide, thousand pounds	534	674	665	730
Kyanite and allied minerals, short tons	63,329	4,942	38,832	3,417
Lime, do	55,852	2,981	32,954	2,185
Magnesium compounds:				
Magnesite, dead-burned, do	71,373	13,466	76,489	16,477
Magnesite, crude, caustic calcined, lump or ground, do	10,121	5,422	12,040	6,336
Mica sheet, waste and scrap, and ground, pounds	14,449,150	3,477	18,202,383	3,557
Mica, manufactured, do	2,481,151	3,776	1,012,977	3,267
Mineral-earth pigments, iron oxide, natural and manufactured, short tons	11,867	11,387	15,529	16,815
Nitrogen compounds (major), thousand short tons	4,714	449,147	5,103	537,739
Phosphate rock, thousand metric tons	9,994	327,410	14,014	362,223
Phosphatic fertilizers:				
Superphosphates, do	1,210	110,835	1,181	110,534
Ammonium phosphates, do	2,182	269,855	2,581	335,883
Elemental phosphorus, short tons	29,038	30,387	17,954	20,722
Mixed chemical fertilizers, thousand metric tons	[r]219	30,284	177	26,908
Pigments and compounds (lead and zinc):				
Lead oxides:				
Pigment grade, short tons	2,620	1,661	NA	NA
Other grade, do	345	438	NA	NA
Zinc oxides:				
Pigment grade, do	4,261	2,587	6,771	3,634
Other grade, do	577	524		
Zinc compounds, do	779	937	435	698
Potash:				
Fertilizer, do	1,669,691	91,887	1,650,200	90,186
Chemical, do	60,025	19,422	40,013	18,805
Pumice and pumicite, do	1,011	271	1,797	516
Salt:				
Crude and refined, thousand short tons	1,007	10,326	1,008	10,881
Shipments to noncontiguous territories, do	18	2,230	17	2,205
Sand and gravel:				
Sand:				
Construction, do	559	1,337	632	1,610
Industrial, do	2,553	17,080	2,457	18,707
Gravel, do	579	1,099	600	1,198
Sodium and sodium compounds:				
Sodium sulfate, do	57	3,636	43	2,801
Sodium carbonate, do	645	[r]47,004	759	52,943
Stone:				
Dolomite, block, do	63	1,486	12	484
Limestone, crushed, ground, broken, do	3,191	10,537	3,235	10,365
Marble and other building and monumental, do	NA	2,596	NA	3,476
Stone, crushed, ground, broken, do	866	7,073	694	6,048
Manufactures of stone, do	NA	2,273	NA	2,242
Sulfur:				
Crude, thousand long tons	1,183	60,226	1,059	47,599
Crushed, ground, flowers of, do	15	3,358	12	4,512
Talc, crude and ground, short tons	212,344	9,034	322,000	9,166
Total	XX	8,484,889	XX	9,171,199

[r] Revised. NA Not available. XX Not applicable.

[1] Adjusted by the Bureau of Mines.

Table 10.—U.S. imports for consumption of principal minerals and products

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS				
Aluminum:				
Metal short tons	575,350	$439,570	670,200	$631,601
Scrap do	85,714	46,166	89,895	63,168
Plates, sheets, bars, etc do	87,560	96,312	75,459	108,736
Aluminum oxide (alumina) do	3,624,367	404,478	4,145,000	512,413
Antimony:				
Ore (antimony content) do	10,023	16,911	3,438	6,832
Needle or liquated do	41	129	259	580
Metal do	2,083	4,986	1,722	4,536
Oxide do	11,611	17,029	9,641	15,150
Arsenic:				
White (As_2O_3 content) do	4,262	1,528	5,981	1,962
Metallic do	288	1,735	357	1,381
Bauxite, crude thousand long tons	12,548	NA	12,784	NA
Beryllium ore short tons	1,058	380	746	298
Bismuth, metal and alloys, gross weight pounds	2,328,051	14,154	2,013,333	10,238
Cadmium:				
Metal short tons	3,411	14,511	2,570	11,680
Flue dust (cadmium content) do	246	536	14	4
Calcium:				
Metal pounds	461,965	475	458,319	706
Chloride short tons	16,046	480	19,708	1,002
Cesium compounds pounds	3,621	147	7,865	329
Chromite:				
Ore and concentrates (Cr_2O_3 content) thousand short tons	533	70,075	538	68,697
Ferrochrome (Cr_2O_3 content) do	150	124,819	134	100,528
Metal do	2	9,142	2	10,893
Cobalt:				
Metal thousand pounds	15,129	66,299	16,833	91,381
Oxide (gross weight) do	138	573	506	2,346
Salts and compounds (gross weight) do	235	365	246	381
Columbium ore do	3,968	[r]5,567	3,364	6,771
Copper (copper content):				
Ore and concentrates short tons	35,197	49,861	18,007	21,423
Regulus, black, coarse do	14,097	54,878	3,257	12,153
Unrefined, black, blister do	19,388	22,144	9,063	11,843
Refined in ingots, etc do	381,343	453,279	386,865	471,666
Old and scrap do	19,735	19,231	19,856	20,741
Ferroalloys, n.s.p.f do	[r]98,524	[r]40,550	107,387	46,541
Gallium kilograms	4,920	2,326	2,884	1,242
Germanium pounds	7,646	1,022	5,904	1,059
Gold (general imports):				
Ore and base bullion troy ounces	166,312	20,007	239,444	35,319
Bullion do	2,489,679	311,011	4,214,656	638,707
Hafnium pounds	3,270	31	3,322	41
Indium thousand troy ounces	290	1,808	291	2,254
Iron ore thousand long tons	44,390	980,348	37,905	956,584
Iron and steel:				
Pig iron short tons	[r]414,663	51,142	372,767	44,916
Iron and steel products (major):				
Iron products do	44,877	32,002	55,758	35,895
Steel products do	[r]14,563,278	[r]4,372,464	19,619,662	5,695,171
Scrap thousand short tons	496	34,524	601	39,723
Tinplate do	12	596	13	778
Lead:				
Ore, flue dust, matte (lead content) short tons	88,988	29,492	97,862	39,812
Base bullion (lead content) do	2,334	955	8,068	4,244
Pigs and bars (lead content) do	141,980	60,245	253,608	149,419
Reclaimed scrap, etc. (lead content) do	2,644	1,022	3,884	1,935
Sheet, pipe, shot do	294	495	980	1,516
Magnesium:				
Metallic and scrap do	13,066	19,020	5,599	6,684
Alloys (magnesium content) do	1,820	3,604	299	1,073
Sheets, tubing, ribbons, wire, other forms (magnesium content) do	21	38	66	219
Manganese:				
Ore (35% or more contained manganese) do	649,245	73,627	454,228	56,357
Ferromanganese (manganese content) do	417,433	164,698	416,081	155,662
Metal do	7,082	5,258	6,841	5,244
Mercury:				
Compounds pounds	35,536	90	21,961	100
Metal 76-pound flasks	44,415	4,325	28,750	3,263
Molybdenum:				
Ore (content) pounds	2,092,623	4,850	2,106,501	5,361
Waste and scrap do	297,554	1,183	2,107,988	1,468
Metal do	[r]136,108	[r]844	143,458	1,536
Compounds do	679,289	690	491,484	573

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS —Continued				
Nickel:				
Ore short tons	6,706	$272	111	$2
Pigs, ingots, shot, cathodes do	111,255	456,398	103,269	451,582
Plates, bars, etc do	3,223	20,348	9,341	33,280
Slurry do	33,280	98,178	24,762	78,039
Scrap do	2,359	4,827	3,175	6,546
Powder and flakes do	10,181	45,267	13,760	67,708
Ferronickel do	55,721	72,161	80,436	95,275
Oxide do	5,932	21,948	4,914	17,477
Platinum-group metals:				
Unwrought:				
Grains and nuggets (platinum) troy ounces	596	88	6,632	1,118
Sponge (platinum) do	904,048	139,378	771,843	125,328
Sweepings, waste, scrap do	146,773	20,080	247,865	18,463
Iridium do	18,179	5,045	8,288	2,225
Palladium do	994,360	48,535	1,102,607	59,683
Rhodium do	62,260	18,342	79,290	31,560
Ruthenium do	75,673	3,580	53,741	4,639
Other platinum-group metals do	224,560	32,195	126,921	16,076
Semimanufactured:				
Platinum do	95,653	15,623	44,405	7,495
Palladium do	128,951	6,325	49,070	2,719
Rhodium do	1,864	382	650	276
Other platinum-group metals do	14,142	1,963	19,062	2,391
Radium: Radioactive substitutes	NA	12,200	NA	15,869
Rare-earth metals:				
Ferrocerium, other cerium alloys short tons	20	167	23	262
Monazite do	2,103	431	5,480	900
Metals, including scandium and yttrium pounds	74	9	91	12
Rhenium:				
Metal, including scrap do	82	38	148	56
Ammonium perrhenate do	4,047	1,407	6,411	1,620
Selenium and selenium compounds do	811,257	12,118	585,673	9,322
Silicon:				
Metal (over 96% silicon content) short tons	^{r}9,630	^{r}11,703	26,806	26,158
Ferrosilicon (silicon content) do	^{r}63,681	^{r}39,648	75,254	44,371
Silver:				
Ore and base bullion thousand troy ounces	16,716	70,206	7,071	30,460
Bullion do	67,187	289,032	69,450	315,343
Sweepings, waste, dore do	4,454	18,823	2,626	10,150
Tantalum ore thousand pounds	2,557	^{r}15,025	1,524	8,941
Tellurium pounds	203,534	1,745	171,291	3,158
Thallium do	66	1	25	2
Tin:				
Ore (tin content) metric tons	5,733	38,529	6,724	60,840
Blocks, pigs, grains, etc do	45,055	325,453	47,774	459,544
Dross, skimmings, scrap, residue, and tin alloys, n.s.p.f do	2,666	3,550	813	1,816
Tinfoil, powder, flitters, etc	NA	8,148	NA	3,733
Tin scrap, and other tin bearing material exluding tinplate scrap do	NA	7,391	NA	9,328
Tin compounds do	176	1,195	170	1,448
Titanium:				
Ilmenite[1] short tons	431,718	18,715	568,307	21,717
Rutile do	281,712	54,849	123,800	24,481
Metal do	^{r}3,638	^{r}9,752	6,881	15,551
Ferrotitanium and ferrosilicon titanium do	899	1,438	1,136	1,991
Compounds and mixtures do	^{r}70,398	53,806	117,078	87,728
Tungsten (tungsten content):				
Ore and concentrate thousand pounds	5,301	28,320	6,919	55,927
Waste and scrap do	170	694	315	2,510
Other alloys do	1,898	11,104	2,473	14,255
Ferrotungsten and ferrosilicon tungsten do	844	5,451	505	4,565
Uranium and other uranium-bearing and nuclear materials:				
Oxide U_3O_8 do	11,074,298	203,926	7,717,679	88,150
Compounds, n.e.c do	33,876,908	441,603	23,531,191	418,028
Metal thousand pounds	NA	NA	70	284
Isotopes (stable) and their compounds	NA	1,067	NA	1,121
Radio isotopes, elements, etc thousand curies	60,302,966	12,200	71,695,692	12,492
Vanadium (content):				
Ferrovanadium thousand pounds	518	2,448	673	3,438
Vanadium-bearing materials (vanadium pentoxide content) do	10,702	7,721	10,057	8,269

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS —Continued				
Zinc:				
Ore (zinc content) short tons	155,803	$50,553	120,457	$37,897
Blocks, pigs, slabs do	695,131	482,265	555,147	359,134
Sheets, etc do	209	329	205	211
Fume (zinc content) do	6,927	2,558	257	516
Waste and scrap	1,803	516	10,128	2,175
Old, dross, skimmings do	12,445	4,884	12,940	5,204
Dust, powder, flakes do	6,009	5,134	7,388	6,277
Manufactures	NA	96	NA	262
Zirconium:				
Ore, including zirconium sand short tons	64,643	13,733	65,204	11,401
Metal, scrap, and compounds do	914	1,153	1,380	10,269
NONMETALS				
Abrasives:				
Diamonds (industrial) thousand carats	^{r}17,047	^{r}61,102	22,640	79,122
Other abrasives	NA	96,130	NA	113,168
Asbestos short tons	657,851	142,145	607,022	145,146
Barite:				
Crude and ground thousand short tons	918	17,829	974	18,176
Witherite short tons	^{r}284	^{r}61	518	108
Chemicals do	16,913	5,095	24,871	7,362
Boron:				
Carbide do	15	240	111	695
Boric acid do	56	14	14,132	5,596
Calcium borate, crude do	30,247	1,953	51,087	3,695
Cement thousand short tons	3,107	67,085	4,038	94,005
Clays:				
Raw short tons	34,359	1,207	31,212	1,335
Manufactured do	4,309	607	4,787	582
Cryolite do	11,325	4,329	11,776	4,279
Feldspar:				
Crude do	93	17,614	--	--
Ground and crushed do	--	--	242	8,115
Fluorspar do	895,254	56,580	971,355	60,298
Gem stones:				
Diamond thousand carats	^{r}5,551	1,011,839	6,411	1,444,537
Emeralds do	1,165	55,286	1,563	64,375
Other	NA	112,241	NA	129,192
Graphite short tons	79,098	6,753	87,556	8,058
Gypsum:				
Crude, ground, calcined thousand short tons	6,253	18,285	7,078	22,139
Manufactures	NA	^{r}3,471	NA	9,259
Iodine, crude thousand pounds	6,482	13,824	6,940	13,831
Kyanite short tons	110	12	58	7
Lime:				
Hydrated do	48,461	1,814	52,875	1,878
Other do	316,442	8,816	370,012	11,192
Lithium:				
Ore do	68	1	--	--
Compounds do	48	621	23	419
Magnesium compounds:				
Crude magnesite do	^{r}20	2	249	11
Lump, ground, caustic-calcined magnesia do	8,194	808	5,788	566
Refractory magnesia, dead-burned, fused magnesite, dead-burned dolomite do	88,035	14,518	75,624	12,995
Compounds do	27,039	2,267	41,878	3,086
Mica:				
Uncut sheet and punch thousand pounds	1,654	941	2,179	988
Scrap do	^{r}4,213	^{r}205	2,348	112
Manufactures do	3,328	3,193	3,267	3,378
Mineral-earth pigments, iron oxide pigments:				
Ocher, crude and refined short tons	^{r}53	11	44	13
Siennas, crude and refined do	624	122	620	171
Umber, crude and refined do	6,908	561	6,957	591
Vandyke brown do	739	147	1,052	194
Other natural and refined do	1,231	190	1,102	226
Synthetic do	40,547	15,523	48,918	19,402
Nepheline syenite:				
Crude do	2,112	38	860	17
Ground, crushed, etc do	499,135	8,785	501,696	9,118
Nitrogen compounds (major), including urea thousand short tons	3,467	296,814	4,738	447,050

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS —Continued				
Peat:				
Fertilizer grade ... short tons	332,433	$28,939	324,058	$30,310
Poultry and stable grade ... do	5,618	553	6,252	612
Phosphate, crude ... metric tons	[r]42	[r]2,209	158	6,079
Phosphatic materials:				
Fertilizer and fertilizer materials thousand metric tons	43	6,631	54	5,095
Ammonium phosphates used as fertilizers ... do	317	44,250	338	39,331
Elemental phosphorous ... do	1	1,604	(2)	1,461
Other phosphatic materials ... do	4	1,032	6	1,133
Pigments and salts:				
Lead pigments and compounds ... short tons	17,836	9,462	22,316	14,724
Zinc pigments and compounds ... do	27,969	15,557	30,154	17,332
Potash ... do	7,595,246	360,756	8,405,338	392,235
Pumice:				
Crude or unmanufactured ... do	3,344	148	6,291	205
Wholly or partly manufactured ... do	78,057	350	247,172	993
Manufactures, n.s.p.f ...	NA	70	NA	133
Quartz crystal (Brazilian pebble) ... pounds	1,148,801	368	1,333,863	780
Salt ... thousand short tons	4,352	23,476	4,529	26,694
Sand and gravel:				
Glass sand ... do	61	489	35	333
Other sand and gravel ... do	292	431	351	392
Sodium compounds:				
Sodium carbonate and bicarbonate ... do	2	155	5	594
Sodium sulfate ... do	316	16,111	223	11,230
Stone and whiting ...	NA	46,211	NA	48,581
Strontium:				
Mineral ... short tons	35,711	1,486	42,986	1,915
Compounds ... do	5,375	[r]2,335	1,759	1,021
Sulfur and compounds, sulfur ore and other forms, n.e.s. thousand long tons	1,727	59,494	1,977	65,154
Talc, unmanufactured ... short tons	20,071	1,861	22,090	2,094
Total ...	XX	[r]14,109,153	XX	16,744,111

[r] Revised. NA Not available. XX Not applicable.

[1] Includes titanium slag averaging about 70% TiO_2, for detail see Titanium chapter.

[2] Less than 1/2 unit.

Table 11.—Comparison of world and U. S. production of selected nonfuel mineral commodities

(Thousand short tons unless otherwise specified)

Minerals	1976 World production[1]	1976 U.S. production	1976 U.S. percent of world production	1977[p] World production[1]	1977[p] U.S. production	1977[p] U.S. percent of world production
METALS, MINE BASIS						
Antimony (content of ore and concentrate) short tons	76,576	283	(2)	78,977	610	1
Arsenic, white do.	38,505	W	NA	37,798	W	NA
Bauxite thousand long tons	76,602	[3]1,958	3	81,102	[3]1,981	2
Beryl short tons	2,675	W	NA	2,656	W	NA
Bismuth thousand pounds	8,532	W	NA	8,844	W	NA
Chromite	9,454	--	--	10,804	--	--
Cobalt (contained) short tons	31,197	--	--	32,611	--	--
Columbium-tantalum concentrate[4] thousand pounds	51,940	--	--	58,759	W	NA
Copper (content of ore and concentrate)	8,272	[5]1,606	19	8,503	1,504	18
Gold thousand troy ounces	39,089	1,048	3	38,966	1,100	3
Iron ore thousand long tons	881,157	[6]79,993	9	844,000	55,751	7
Lead (content of ore and concentrate)	3,677	610	17	3,759	592	16
Manganese ore (35% or more Mn)	27,153	--	--	24,267	--	--
Mercury thousand 76-pound flasks	240	23	10	199	28	14
Molybdenum (content of ore and concentrate) thousand pounds	191,736	113,233	59	205,921	122,408	59
Nickel (content of ore and concentrate)	905	16	2	852	14	2
Platinum-group metals thousand troy ounces	5,979	6	(2)	6,386	6	(2)
Silver do.	312,150	34,328	11	325,475	38,166	12
Tin (content of ore and concentrate) metric tons	228,005	W	NA	231,438	W	NA
Titanium concentrates:						
Ilmenite	3,526	652	18	3,723	639	17
Rutile[4]	471	W	NA	396	W	NA
Tungsten concentrate (contained tungsten) thousand pounds	91,767	5,830	6	93,630	6,008	6
Uranium oxide (U_3O_8)[4] short tons	28,234	11,521	41	34,616	13,426	39
Vanadium (content of ore and concentrate) do.	31,271	7,376	24	33,317	6,504	20
Zinc (content of ore and concentrate)	6,358	485	8	6,683	450	7
METALS, SMELTER BASIS						
Aluminum	13,771	4,251	31	15,049	4,539	30
Cadmium short tons	18,180	[7]2,256	12	18,898	2,204	12
Copper	8,039	[8]1,535	19	18,278	1,435	17
Iron, pig	551,193	86,848	16	542,696	81,494	15
Lead	3,811	[9]653	17	3,847	[9]605	16
Magnesium	149	W	NA	151	W	NA
Selenium[4] thousand pounds	2,501	401	16	3,019	499	17
Steel ingots and castings	747,103	[10]128,000	17	741,648	[10]125,333	17

Tellurium[4]	thousand pounds	NA	W	NA	NA	W	NA
Tin	metric tons	229,861	[11]5,700	2	230,243	[11]6,700	3
Zinc		5,908	499	8	6,041	450	7
NONMETALS							
Asbestos		5,623	115	2	5,879	102	2
Barite		5,666	1,234	22	5,892	1,494	25
Cement		810,656	[12]74,495	9	856,939	[12]80,060	9
Clay, china		18,247	[13]6,115	34	18,795	[13]6,469	34
Corundum		9	--	--	10	--	--
Diamond	thousand carats	38,073	--	--	39,470	--	--
Diatomite		1,919	631	33	1,976	648	33
Feldspar		2,936	740	25	3,045	734	24
Fluorspar		4,932	188	4	5,148	169	3
Graphite		498	W	NA	504	W	NA
Gypsum		69,175	11,980	17	72,164	13,390	19
Lime (sold or used)		119,117	[12]20,257	17	121,649	[12]19,987	16
Magnesite		9,847	W	NA	9,753	W	NA
Mica (including scrap)	thousand pounds	494,596	281,429	57	587,437	352,759	60
Nitrogen, agricultural[14]		48,291	[12]10,572	22	50,565	[12]10,792	21
Peat		222,745	774	(2)	223,577	781	(2)
Phosphate rock	thousand metric tons	107,616	44,662	42	115,948	47,256	41
Potash (K_2O equivalent)		26,741	2,400	9	28,356	2,457	9
Pumice[4]		17,375	4,181	24	17,060	4,011	24
Pyrites (sulfur content)	thousand long tons	9,311	286	3	9,127	166	2
Salt		185,324	[12]44,218	24	187,292	[12]43,439	23
Strontium[4]		67	--	--	74	--	--
Sulfur, elemental	thousand long tons	49,697	10,707	22	50,649	10,558	21
Talc, pyrophyllite, soapstone		5,976	1,092	18	6,331	1,205	19
Vermiculite[4]		577	304	53	570	359	63

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[p] Preliminary. NA Not available. W Withheld to avoid to disclosing company proprietary data.

[1] May not represent total world production because confidential U.S. data are excluded for some commodities. World totals include reported figures and reasonable estimates; however, for some commodities where data were not available, no reasonable estimates could be made and none have been included.

[2] Less than 1/2 unit.

[3] Dry bauxite, equivalent of crude ore.

[4] World total exclusive of the U.S.S.R.

[5] Recoverable.

[6] Includes byproduct ore.

[7] Includes secondary.

[8] Smelter output from domestic and foreign ores, exclusive of scrap.

[9] Lead refined from domestic and foreign ores; excludes lead refined from imported base bullion.

[10] Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingot.

[11] Includes tin content of alloys made directly from ore.

[12] Includes Puerto Rico.

[13] Kaolin sold or used by producers.

[14] Year ended June 30 of year stated (United Nations).

The Mineral Industry of Alabama

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Alabama for collecting information on all minerals.

By James R. Boyle[1] and T. L. Neathery[2]

The value of mineral production increased 13% in 1977. Nearly all commodities registered an increase in production and value, continuing a trend that started in 1976. In addition, practically all commodities registered an increase in unit value. Alabama led the Nation in the production of crushed marble, was second in bauxite and scrap mica, third in kaolin and oyster shell, and fourth in bentonite, dimension marble, and fire clay.

Table 1.—Mineral production in Alabama[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Cement:				
Masonry ______ thousand short tons__	314	$13,671	345	$14,255
Portland ______do____	2,134	70,365	2,351	79,302
Clays[2] ______do____	2,239	10,325	2,677	21,984
Coal (bituminous) ______do____	21,537	611,069	21,545	622,187
Lime______do____	1,009	32,753	1,149	39,213
Natural gas ______million cubic feet__	41,427	40,806	57,227	84,124
Petroleum (crude)______ thousand 42-gallon barrels__	14,706	155,437	18,252	176,540
Sand and gravel______ thousand short tons__	12,023	20,933	14,372	35,204
Stone ______do____	23,832	65,429	25,262	74,364
Combined value of asphalt (native), bauxite, clays (bentonite), mica (crude), natural gas liquids, and salt ______	XX	8,748	XX	12,779
Total ______	XX	1,029,536	XX	1,159,952
Total 1967 constant dollars______	XX	528,461	XX	[p]572,552

[p]Preliminary. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes bentonite; included with "Combined value" figure.

Table 2.—Value of mineral production in Alabama, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Autauga	W	W	Sand and gravel.
Baldwin	W	W	Sand and gravel, clays.
Barbour	W	W	Clays, bauxite, sand and gravel.
Bibb	W	W	Stone, clays.
Blount	W	W	Sand and gravel, cement, stone.
Calhoun	W	W	Stone, clays, sand and gravel.
Cherokee	$2,609	$101	Sand and gravel.
Chilton	W	W	Sand and gravel, clays.
Choctaw	43,376	--	
Clarke	W	W	Sand and gravel.
Clay	3	4	Do.
Coffee	89	81	Do.
Colbert	W	W	Stone, native asphalt, sand and gravel.
Conecuh	W	W	Sand and gravel.
Covington	--	W	Do.
Crenshaw	20	22	Do.
Cullman	17,655	--	
Dale	W	215	Sand and gravel.
Dallas	W	W	Sand and gravel, clays.
De Kalb	W	W	Stone.
Elmore	W	W	Sand and gravel, clays.
Escambia	75,075	W	Do.
Etowah	W	W	Stone, sand and gravel.
Fayette	W	184	Sand and gravel.
Franklin	W	W	Stone, sand and gravel.
Geneva	8	W	Sand and gravel.
Hale	7	270	Do.
Henry	W	W	Clays, bauxite, stone.
Houston	W	W	Sand and gravel.
Jackson	W	W	Stone.
Jefferson	W	W	Cement, stone, clays, sand and gravel.
Lamar	5,365	W	Sand and gravel.
Lawrence	6	--	
Lee	W	W	Stone.
Lowndes	W	W	Clays, sand and gravel.
Macon	2,069	2,207	Sand and gravel.
Madison	W	W	Stone, sand and gravel, clays.
Marengo	W	W	Cement, stone.
Marion	W	320	Sand and gravel, clays.
Marshall	W	W	Stone, sand and gravel, clays.
Mobile	82,674	22,882	Cement, sand and gravel, stone, clays.
Monroe	1,379	38	Sand and gravel.
Montgomery	W	W	Sand and gravel, clays.
Morgan	W	W	Stone.
Randolph	W	W	Mica.
Russell	W	817	Sand and gravel, clays.
St. Clair	W	W	Cement, clays, stone.
Shelby	82,377	W	Lime, cement, stone, clays.
Sumter	W	W	Sand and gravel, clays.
Talladega	W	W	Stone.
Tuscaloosa	68,771	989	Sand and gravel.
Walker	W	199	Clays.
Washington	20,072	W	Stone, salt, sand and gravel.
Winston	12,295	--	
Undistributed[3]	615,690	1,131,623	
Total	[4]1,029,536	1,159,952	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Bullock, Butler, Chambers, Cleburne, Coosa, Greene, Lauderdale, Limestone, Perry, Pickens, Pike, Tallapoosa, and Wilcox.

[2] Values for petroleum and natural gas were based on an average price per barrel for the State.

[3] Includes some petroleum which cannot be assigned to specific counties and values indicated by symbol W.

[4] Data do not add to total shown because of independent rounding.

International Trade.—The international trade passing through the Port of Mobile was valued at $1,376 million in fiscal year 1977, down 45% from the previous year. Imports were down 36% and exports down 1%. The Port of Mobile handled significant tonnages of raw materials during the year. The major export commodity was coal through McDuffie Coal Terminal which amounted to 3.4 million tons, up from 2.9 million tons in 1976. The majority of the coal was shipped to Japan. Some 250,000 tons, mined in Georgia, was exported to Brazil. Other exports were cement (126,000 tons) and alumina (219,000 tons). Imported commodities included coal (203,800 tons), bauxite (1.7 million tons), limenite (80,000 tons), manganese (484,000 tons), and iron ore (1.3 million tons). In addition, general port tonnage included nearly 3.0 million tons of ore, mostly iron ore.

Trends and Developments.—A new $33 million ferrosilicon furnace, a joint venture of International Minerals & Chemical Corp.'s (IMC) TAC Alloys division and Allegheny Ludlum Steel Corp., was dedicated at Bridgeport. The 40-megawatt furnace replaces three smaller furnaces which have operated for a number of years. The new electric furnace will result in a 50% increase in IMC's ferrosilicon capacity, and is designed to permit production of both 50% and 75% ferrosilicon, with an annual production of about 75,000 tons of 50% equivalent.

Drummond Co. of Jasper, Alabama's largest producer of surface mined coal, acquired control of Alabama Byproducts Corp. (ABC) of Birmingham. ABC produces foundry coke, operates seven coal mines and a preparation plant, and is considered one of the largest producers of foundry coke in the Nation. With this acquisition, Drummond Co. acquired its first underground mining operation.

Southern Natural Resources, Inc., Birmingham, was one of five interstate natural gas pipeline companies to sign a letter of intent to receive gas from old and new gasfields in Mexico. Southern Natural will receive 200 million cubic feet per day, of which one-third, or 66.7 million cubic feet per day, has been committed to Florida Gas Transmission Co.

Alabama Power Co. has abandoned plans for its proposed $3 billion Alan Barton Nuclear Plant in Chilton and Elmore Counties. The company's president cited unsettled and continuously changing licensing, safety, and environmental requirements of the Federal Nuclear Regulatory Commission, as reasons for cancellation of the Barton plant. To make up the difference in generating capacity, Alabama Power will build other powerplants including a fourth unit at the Miller Steam Plant in West Jefferson, near Birmingham.

United States Steel Corp.'s third bottom-blown oxygen (Q-BOP) steelmaking furnace was completed during the year at their Fairfield works. The 57-oven coke battery and blast furnace under construction are expected to go into operation early in 1978.

The State's Department of Industrial Relations reported that due to the record cold winter, 19,800 workers in industrial plants were idled because of a shortage of natural gas. More workers were not affected because numerous industries have standby systems to which they switched when natural gas supplies were cut off.

Golco Resources, Inc., a subsidiary of Colonial Oil and Gas Corp. of Rochester, N.Y., has begun using the State docks facility at Cordova for shipments of coal to inland waterpoints and to Mobile for export. A 10-year lease agreement has been signed by Colco and the State of Alabama providing docking and coal-handling facilities at Cordova. Plans are underway for $2.5 million in construction for the coal-handling facility, with plans to ship 50,000 tons of coal per month.

Dedication ceremonies were held in Mobile for a Kerr-McGee Chemical Corp. plant that is the first stage in a $100 million pigment manufacturing and processing complex. The new plant will provide synthetic rutile both for a pigment plant to be built in Mobile and for a similar 10-year-old plant in Hamilton, Miss. The Hamilton plant and the projected Mobile plant have capacities of 50,000 tons each of titanium dioxide annually, and the synthetic rutile plant will produce 110,000 tons of the raw material annually to be used in both plants.

The Aluminum Company of America (Alcoa), State officials, and environmental groups are detailing plans for reclaiming and developing 600 acres of Alcoa property on Blakely Island into a wildlife sanctuary. Eventually, the entire tract, located next to Polecat Bay in Alabama's gulf water network, will be deeded to the State. The bauxite refining plant's plans call for the planting of trees and grasses and the building of fresh water lakes on land now serving as a process spoils disposal site.

Reynolds Metals Co.'s Alabama smelting plant for recycling aluminum at Sheffield is being expanded for the second time since it began operations in 1969. The expansion includes a third melting furnace, rated at 150,000 pounds, and 32,000 more square feet of floor space. An additional baghouse will be installed for environmental protection. The plant will be rated at 200 million pounds output annually on completion of the expansion in 1978.

The Alabama Conservancy is drawing up proposals to have 76,000 acres of national forest in Alabama declared wilderness areas. The proposals include 40,000 acres in Bankhead National Forest, 21,000 acres in the Oakmulgee division of the Talladega National Forest, 12,220 acres in the Talladega division of the Talladega National Forest, and 3,000 acres in the Tuskegee National Forest. The Conservancy director said he considers the wilderness proposal a "last chance" at having forest lands declared hands-off to the timber industry. The proposals will be sent to U.S. Forest Service in Montgomery, then in turn to Washington, and will probably wind up in an omnibus wilderness bill before Congress in the next 2 years, according to the Conservancy director.

Legislation and Government Programs.—Thomas J. Joiner was named State Geologist for the Geological Survey of Alabama and Oil and Gas Supervisor. Mr. Joiner had been acting in these positions since late 1976. The appointment was made by University of Alabama President David Mathews, with the approval of Governor George Wallace. Mr. Joiner was sworn in to his new duties late in the year.

The Geological Survey of Alabama conducted a multifaceted program and issued publications on various subjects, which included energy, general geology, and mineral resource maps of various counties. A multiyear environmental, geologic, and hydrologic study of Jefferson County was underway.

A separate Department of Mineral Engineering has been established in the College of Engineering at the University of Alabama due to increased enrollment and the Nation's energy situation. A Chair of Mining was also created at the University. The new chair was made possible through contributions from the mining industry.

The Federal Bureau of Mines, through the Intergovernmental Personnel Act, loaned a mining engineer to the Alabama Surface Mining Reclamation Commission. The engineer was the chief technical advisor to the Commission, and one of his first duties was to develop a blasting course to prepare blasters for certification as required by law.

Alabama's entire 13,000-square-mile coalfields will be mapped for the first time with color-infrared and black and white aerial photography early in 1978. The Alabama Surface Mining Reclamation Commission will contract out for these services. The project will give the agency up-to-date information on more than 400 existing mines, coal reserves, and other geological information.

The State Conservation Department announced that it will accept nominations for the leasing of oil and gas tracts on all the submerged State land lying seaward from the shore in the Gulf of Mexico to the 3-mile limit. The deadline for acceptance of these nominations will be January 11, 1978.

The Mineral Resources Institute received a grant of $56,000 from the National Science Foundation to conduct a study to determine if it is economically feasible to resume mining of Appalachian iron ores, particularly those in the Birmingham region. Evaluations will be made of the technological advancements for beneficiating the iron ores. In addition, the technical needs for making the industry competitive will be identified. The data collected will be tested for technical and economic accuracy using modular configurations that embrace combinations of mining, processing, and smelting technologies. The Mineral Resources Institute in Tuscaloosa is a research and service arm of the University of Alabama.

A new severance tax of 20 cents per ton, in addition to the 13.5-cent tax imposed in 1971, was signed into law. All additional revenues from the new tax will go to counties, municipalities, and police jurisdictions where the coal is mined. Cities with mines in their police jurisdictions will receive 10 cents for each ton mined.

Dr. Bruce Trickey has been named acting executive director of the Alabama Coastal Area Board. Dr. Trickey will become permanent director following his retirement at the end of the year as plant manager of the Ciba-Geigy Corp. in McIntosh. Dr. Trickey will be responsible for assembling information and plans concerning coastal zone management of Alabama.

Table 3.—Indicators of Alabama business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,474	1,533	+4.0
Unemployment	do	100	114	+14.0
Employment (nonagricultural):				
Mining	do	13.3	13.8	+3.8
Manufacturing	do	340.2	352.5	+3.6
Contract construction	do	68.7	75.9	+10.5
Transportation and public utilities	do	61.9	64.9	+4.8
Wholesale and retail trade	do	245.3	258.2	+5.3
Finance, insurance, real estate	do	53.2	56.0	+5.3
Services	do	171.5	177.7	+3.3
Government	do	252.9	261.4	+3.4
Total nonagricultural employment	do	1,207.0	1,259.8	+4.4
Personal income:				
Total	millions	$18,771.0	$20,745.0	+10.5
Per capita		$5,138.0	$5,622.0	+9.4
Construction activity:				
Number of private and public residential units authorized		17,235	23,562	+36.7
Value of nonresidential construction	millions	$278.8	$325.6	+16.8
Value of State road contract awards	do	$129.2	$192.0	+48.6
Shipments of portland and masonry cement to and within the State	thousand short tons	1,493	1,537	+2.9
Mineral production value:				
Total crude mineral value	millions	$1,029.5	$1,160.0	+12.7
Value per capita, resident population		$281	$314	+11.7
Value per square mile		$19,949	$22,476	+12.7

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

The Alabama Air Pollution Control Commission (AAPCC) is notifying municipal and county agencies and demolition companies that they must comply with regulations in tearing down or renovating commercial or industrial buildings containing materials with more than 1% asbestos. Regulations call for the asbestos to be removed and disposed of before dismanteling operations begin unless the asbestos is encased in concrete. Polluting of the air with asbestos during stripping operations must be controlled by mixing or coating the material with water.

The Tuscaloosa Office of the Federal Bureau of Land Management has announced the Bureau's intent to contract services for a cultural resources inventory of Federal mined lands in Walker, Fayette, Tuscaloosa, and Jefferson Counties. The objective is to obtain an inventory and sample survey to identify and evaluate the nature, distribution, and potential significance of all cultural resources associated with Federal mineral lands in the four-county area.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels accounted for 77% of the total value of mineral production, an increase over that of 1976. All mineral fuels had an increase in production and unit value.

Coal production increased slightly despite several short wildcat strikes during the year and an industry-wide strike in December. Jim Walter Resources, Inc., continued development of several underground coal mines with plans to convert at least one to longwall. United States Steel Corp. started development of an underground coal mine in Shelby County. Expansions are also underway by several companies operating surface mines.

Gas and petroleum production also increased. The gasfields in the Black Warrior Basin, shut-in because of pipeline problems, had some relief with the construction of a pipeline to Tuscaloosa. Some 12 to 15 million cubic feet of gas per day will be piped into the Alabama Gas Co.'s lines.

NONMETALS

Nonmetals accounted for 23% of the

State's total mineral production value. Nearly all commodities registered an increase in production and value.

Cement.—Cement accounted for the bulk of the mineral value of nonmetallics. Portland cement was produced at seven plants in the State; three plants in Jefferson County, and one plant each in Marengo, Mobile, St. Clair, and Shelby Counties.

Portland cement shipments in 1977 increased 10.2%, while masonry increased 9.9%. Unit value of portland cement increased 2.3%, while that for masonry cement decreased 5.1%. Stocks of both portland and masonry cements decreased about 15%.

The expansion and rebuilding programs by the cement industry have included various pollution controls and energy saving devices. The new or rebuilt plants reportedly meet the requirements of the Federal and State agencies regulating water and air pollution. Many of the new plants require up to 30% less fuel for kiln operations. These plants also include coal as either the primary or standby fuel for the kiln.

Table 4.—Alabama: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	7	7
Production	2,097,694	2,339,704
Shipments from mills:		
Quantity	2,133,892	2,351,264
Value	$70,365,440	$79,301,695
Stocks at mills, Dec. 31	223,449	190,788

Table 5.—Alabama: Masonry cement salient statistics

(Short tons)

	1976	1977
Number of active plants	7	6
Production	311,996	338,780
Shipments from mills:		
Quantity	314,057	345,462
Value	$13,670,992	$14,255,072
Stocks at mills, Dec. 31	26,658	22,669

Water and air pollution equipment accounts for almost one-fourth of the $60 million expended in the construction of a new plant for Citadel Cement Corp. in Demopolis. Output of the ultramodern, computer-controlled facility will be 750,000 tons of bulk cement per year, compared with 200,000 annually in the old plant. This plant is the first all-new facility to be constructed for Citadel Cement Corp. Permission by the Alabama Air Pollution Control Commission allowed the old facility to operate until a few months before the new construction was completed. One of the electrostatic precipitators cost $3.5 million, plus another $1 million for installation. There are 31 dust collectors placed throughout the facility at transfer points.

Ideal Cement announced plans to build a new $175 million plant in Theodore Industrial Park. It will expand and replace an existing Mobile plant. The parent corporation, Ideal Basic Industries, Inc. of Denver, Colo. announced plans to start construction of the 1.5-million-ton-per-year production plant as soon as environmental permits are approved, with parallel development of companion limestone and clay quarries in Monroe County to furnish raw materials.

Modifications to the new $4.5 million environmental control system at Universal Atlas Cement's Leeds Plant were completed and break-in operations were underway.

Clays.—Production of clay increased 19.6% to nearly 2.7 million tons. An average unit value increase of 78.1% more than doubled the total value of clay mined to nearly $22 million. Of the total mined, nearly 2.1 million tons was common clay with fire clay and kaolin accounting for the other 600,000 tons. Nearly 900,000 tons of common clay was used in the manufacture of brick.

Thirty companies mined clay at 42 pits in 20 counties; 19 companies mined common clay at 27 pits; five companies mined fire clay at 6 pits; and 6 companies mined kaolin at 9 pits.

Of the 42 pits, 90% of the total production of clays came from 24 pits.

Lime.—Production of lime exceeded 1 million tons for the third time. Production came from five plants in Shelby County and increased 13.9%, with value increasing 19.7%. Major uses include basic oxygen steel furnaces, paper manufacture, and water purification.

Mica.—Western Mica Co. produced scrap mica at its Heflin operation from material mined in Randolph County. Alabama ranked fourth in the Nation in the production of scrap mica.

Mullite.—Harbison-Walker Refractories manufactured synthetic mullite at its Eufaula operations from material mined in Henry County.

Salt.—The Olin Corp. produced salt from well brines in Washington County for use in chemical manufacture, primarily soda ash and polyvinyl chloride plastics. The soda ash is generally used to manufacture caustic soda for use in the paper and alumina industries.

Table 6.—Alabama: Lime sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Paper and pulp	317	10,143	431	14,691
Water purification	112	3,735	129	4,383
Sewage treatment	63	2,044	W	W
Soil stabilization	55	1,911	W	W
Mason's lime	12	428	W	W
Sugar refining	W	W	7	248
Other uses[1]	451	14,492	582	19,891
Total	[2]1,009	32,753	1,149	39,213

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes steel, BOF; other construction lime; aluminum and bauxite; other chemical uses; steel, electric; open-hearth steel furnaces; alkalies, food and food byproducts; calcium carbide; tanning; agriculture; acid mine water; oil well drilling; ore concentration; other metallurgy (1976); precipitated calcium carbonate (1976); petroleum refining (1976); sulfur removal (1976); finishing lime (1976); insecticides (1976); fertilizer (1976); and uses indicated by symbol W.

[2] Data do not add to total shown because of independent rounding.

Sand and Gravel.—Sand and gravel production increased 19.5%, while value increased 68.2% over that of 1976. This value increase was due mainly to an increase in unit value. Sand and gravel was produced at 101 operations in 38 counties, up from 95 operations in 38 counties in 1976. Nearly 90% of all the sand and gravel was used for construction purposes, with the balance for industrial purposes. Construction sand and gravel averaged $2.19 per ton, while industrial was $4.66 per ton. Leading counties were Montgomery, Mobile, Elmore, and Autauga. Of the operating pits, the top 40 produced 80% of the total tonnage and 83% of the value of production.

Stone.—Georgia Marble Co., Moretti-Harrah Marble Co., Lamb Stone Co., and Brown Stone Co. quarried dimension stone at 14 quarries for cut stone (49%), rubble, rough blocks, dressed monumental stone, and other uses. Output declined 19% to 14,000 tons valued at $1.7 million. Crushed stone was produced by 27 companies at 49 quarries for roadstone, cement, roadbase stone, and other uses. Output increased 6% to a record of over 25 million tons, with value increasing 15% to $72.6 million. Leading companies were Vulcan Materials Co., Southern Industries, and Wade Sand and Gravel Co., Inc.

Among the States, Alabama led in production of crushed marble, ranked third in output of shell, and fourth in dimension marble.

Table 7.—Alabama: Sand and gravel sold ur used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	6,584	$12,781	$1.94
Gravel	6,286	15,420	2.45
Total or average	[1]12,869	28,201	2.19
Industrial:			
Sand	W	W	W
Gravel	W	W	W
Total or average	1,503	7,003	4.66
Grand total or average	14,372	35,204	2.45

W Withheld to avoid disclosing company proprietary data.

[1] Data do not add to total shown because of independent rounding.

Table 8.—Alabama: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	7,045	$16,941	$2.40
Concrete products	1,307	3,338	2.55
Asphaltic concrete	1,758	4,016	2.28
Roadbase and coverings	1,657	2,568	1.55
Fill	1,013	1,090	1.08
Other uses	89	248	2.79
Total or average	12,869	28,201	2.19

Table 9.—Alabama: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	2,353	4,991	5,065	9,531
Cement manufacture	4,209	8,893	4,475	9,564
Dense-graded roadbase stone	3,119	6,881	3,319	7,781
Concrete aggregate	3,414	6,432	2,704	6,336
Bituminous aggregate	2,499	5,319	2,603	6,379
Lime manufacture	2,021	6,568	1,813	8,314
Agricultural limestone	1,478	5,117	1,595	4,819
Flux stone	1,385	2,718	1,577	3,809
Other filler	600	W	545	7,971
Riprap and jetty stone	437	1,088	402	1,036
Surface treatment aggregate	861	1,859	274	520
Railroad ballast	104	225	108	232
Chemicals	473	W	--	--
Other uses[2]	862	13,105	767	6,356
Total[3]	23,815	63,195	25,248	72,649

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, shell, marble, and sandstone.

[2] Includes stone used for mineral food, whiting, macadam aggregate, mine dusting (1977), terrazzo and exposed aggregate, asphalt filler (1977), filter stone (1977), refractory stone, other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Sulfur.—Three companies recovered sulfur from four sour crude processing plants in Escambia and Washington Counties. Exxon Co. U.S.A., Mallard Exploration, Inc., and Phillips Petroleum Co. sold 280,000 long tons valued at nearly $12.8 million. Alabama ranked fifth nationally in output of recovered sulfur.

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[1] State Liaison Officer, Bureau of Mines, Tuscaloosa, Ala.

[2] Chief geologist, Mineral Resources, Geological Survey of Alabama, Tuscaloosa, Ala.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Alumina:			
Aluminum Company of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Mobile.
Aluminum smelters:			
Revere Copper & Brass Inc	Box 191 Rome, NY 13440	do	Jackson.
Reynolds Metals Co	Reynolds Metals Bldg. Richmond, VA 23218	do	Colbert.
Bauxite:			
Eufaula Bauxite Milling Co	Box 556 Eufaula, AL 36027	Mine and plant	Barbour.
United States Gypsum Co.[1]	Mexico, MO 65265	do	Do.
Wilson-Snead Mining Co	Box 568 Eufaula, AL 36027	do	Barbour and Henry.
Cement:			
Alpha Portland Industries, Inc	15 South Third St. Easton, PA 18042	Plant	Jefferson.
Citadel Cement Corp	2625 Cumberland Pkwy., NW Atlanta, GA 30339	do	Do.
Ideal Basic Industries, Inc.[2]	821 17th St. Denver, CO 80202	do	Mobile.
Lone Star Industries, Inc.[3]	1 Greenwich Plaza Greenwich, CT 06880	Plants	Jefferson and Marengo.
Martin Marietta Corp.[4]	277 Park Ave. New York, NY 10017	do	Jefferson and Shelby.
National Cement Co	Box 3358 Birmingham, AL 35205	do	St. Clair.
Clays:			
American Colloid Co	5100 Suffield Court Skokie, IL 60076	Mine	Lowndes.
Donoho Clay Co	Box 843 Anniston, AL 36202	do	Calhoun.
Dresser Industries	2 Gateway Center Pittsburgh, PA 15222	do	Henry.
Riverside Clay Co	Box 551 Pell City, AL 35125	do	St. Clair.
Coal:			
Alabama By-Products Corp.[5]	Box 354 Birmingham, AL 35210	Underground mines, strip mine, plant.	Jefferson.
The Drummond Co	Box 1549 Jasper, AL 35501	Strip mines	Walker.
Jim Walter Resources, Inc	Box 10406 Birmingham, AL 35202	Underground mines	Jefferson.
Republic Steel Corp	Box 6778 Cleveland, OH 44101	do	Do.
United States Steel Corp	Box 559 Fairfield, AL 35064	do	Do.
Coke:			
Empire Coke Co	2201 First Ave., North Birmingham, AL 35203	Plant	Tuscaloosa.
Ferroalloys:			
Airco Alloys and Carbide	Box 368 Niagara Falls, NY 14302	do	Mobile.
Alabama Metallurgical Corp	Box 348 Selma, AL 36701	do	Selma.
Tennessee Alloys Corp	818 National Bank Bldg. Chattanooga, TN 37402	do	Jackson.
Tennessee Valley Authority	Muscle Shoals, AL 35660	do	Colbert.
Union Carbide Corp	Box 176 Marietta, OH 45750	Plants	Colbert and Jefferson.
Woodward Co.[6]	Woodward, AL 35189	Plant	Jefferson.
Lime:			
Alabaster Lime Co	Siluria, AL 35144	do	Shelby.
Allied Products Co	Drawer 1 Montevallo, AL 35115	do	Do.
Cheney Lime & Cement Co.[7]	Allgood, AL 35013	do	Do.
S. I. Lime Co	500 Southland Dr. Birmingham, AL 35226	do	Do.
Natural gas:			
Black Warrior Petroleum Co., Inc.	Box 1642 Mobile, AL 36601	Gasfield	Escambia.
Natural gas liquids:			
Cities Service Oil Co	Box 300 Tulsa, OK 74102	Plant	Mobile.
Petroleum (crude):			
Ancora Corp	1 Jackson Place, Suite 620 San Francisco, CA 94111	Wells	Do.
E. L. Erickson	1235 Petroleum Bldg. Jackson, MS 39201	do	Choctaw.
Humble Oil & Refining Co	Box 2180 Houston, TX 77001	do	Escambia.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Petroleum (crude) —Continued			
Louisiana Land & Exploration Co.	Box 60350 New Orleans, LA 70160	Wells	Escambia.
Patrick Petroleum	744 Michigan Ave. Jackson, MI 49201	do	Baldwin and Clarke.
Pruett & Hughes Co	390 Petroleum Bldg. Jackson, MS 39201	do	Choctaw.
Sun Oil Co	Box 2880 Dallas, TX 75221	do	Mobile.
Petroleum refineries:			
Alabama Refining Co	Mobile, AL 36600	Plant	Do.
Hunt Oil Co	Tuscaloosa, AL 35401	do	Tuscaloosa.
Vulcan Asphalt Refining Co	Cordova, AL 35550	do	Walker.
Warrior Asphalt Co	Tuscaloosa, AL 35401	do	Tuscaloosa.
Pig iron:			
Republic Steel Corp.[5]	1629 Republic Bldg. Cleveland, OH 44115	Furnaces and mills	Etowah and Jefferson.
U.S. Pipe and Foundry Company.[5]	3300 First Ave. North Birmingham, AL 35202	Furnaces	Jefferson.
United States Steel Corp.[8]	Box 599 Fairfield, AL 35064	Furnaces and mills	Do.
Salt:			
Olin Corp	120 Long Ridge Rd. Stanford, CT 06904	Brine wells	Washington.
Sand and gravel:			
Dixie Sand & Gravel	Box 1128 Montgomery, AL 36102	Dredge and plant	Montgomery.
Radcliff Materials, Inc.[9]	Mobile, AL 36601	Dredge	Mobile.
W. T. Ratcliff Co., Inc	Box 1111 Knoxville, TN 37901	Surface mine and plant.	Clarke.
Southern Industries Inc	61 St. Joseph Mobile, AL 36602	Pit and dredge	Elmore and Montgomery.
Stone:			
Southern Stone Co., Inc	2111 8th Ave., South Birmingham, AL 35233	Quarry	Bibb, Colbert, Lee, Shelby.
Trinity Stone Co., Inc	Drawer E Decatur, AL 35601	do	Morgan.
Vulcan Materials Co.[10]	Box 7324-A Birmingham, AL 35223	Quarries	Calhoun, Colbert, Etowah, Franklin, Jackson, Madison, Shelby.
Wade Sand and Gravel Co., Inc	Box 39048 Birmingham, AL 35208	Quarry	Jefferson.
Talc:			
American Talc Co., Inc	Alpine, AL 35014	Surface mine and plant.	Talladega.

[1] Also clays and scrap mica.
[2] Also clays.
[3] Also stone.
[4] Also lime, stone, clays.
[5] Also coke.
[6] Also coal, coke, pig iron.
[7] Also cement.
[8] Also cement, coal, coke, stone.
[9] Also clay and shell.
[10] Also clays, and sand and gravel.

The Mineral Industry of Alaska

By Alfred L. Service[1]

Mineral production value, excluding energy minerals, fell off by about 32% in 1977, the result of declines in output of construction materials (sand and gravel and stone). The Alaska Division of Geological and Geophysical Surveys (DGGS) processed 17,378 new mining claims in 1977, 31% more than in 1976. There were 2,008 affidavits of labor filed on 44,146 active claims, 20% more than in 1976. The total number of active claims in the State increased to 61,524. DGGS estimated that approximately $45 million was expended on exploration activity.

Legislation and Government Programs.—DGGS continued minerals investigations and geologic mapping to provide information and background data related to pending D-2 land bills in Congress and for the selection of State lands. New mapping programs were started in the Lime Hills, Lake Clark, and Iliamna areas and in the Yukon-Kuskokwim region.

Table 1.—Mineral production in Alaska[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Coal (bituminous) thousand short tons	706	W	705	W
Gem stones	NA	$60	NA	$60
Gold (recoverable content of ores, etc.) troy ounces	22,887	2,868	18,962	2,812
Lead (recoverable content of ores, etc.) short tons	14	6	--	--
Natural gas million cubic feet	166,072	64,602	187,889	75,531
Petroleum (crude) thousand 42-gallon barrels	63,398	318,789	169,201	988,877
Sand and gravel thousand short tons	74,208	204,738	66,426	134,251
Silver (recoverable content of ores, etc.) thousand troy ounces	3	14	2	8
Stone:				
Crushed thousand short tons	6,727	20,092	4,008	17,493
Dimension do	--	--	([2])	1
Combined value of copper (1977), natural gas liquids, platinum (1976), tungsten (1977), and items indicated by symbol W	XX	14,019	XX	14,486
Total	XX	625,188	XX	1,233,519
Total 1967 constant dollars	XX	320,909	XX	^{p}608,865

^{p}Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production.

[2] Less than 1/2 unit.

Table 2.—Value of mineral production in Alaska, by region[1] [2]

(Thousands)

Region	1976	1977	Minerals produced in 1977 in order of value
Bristol Bay	--	$8	Sand and gravel.
Cook Inlet-Susitna	$5,200	4,011	Sand and gravel, stone, gold, silver.
Copper River	W	W	Sand and gravel, stone, gold, copper, silver.
Kenai Peninsula	381,816	454	Sand and gravel.
Kodiak	651	W	Sand and gravel, stone.
Kuskokwim	W	W	Sand and gravel.
Northern Alaska	--	W	Do.
Seward Peninsula	W	W	Sand and gravel, stone.
Southeastern Alaska	13,532	W	Stone, sand and gravel, tungsten.
Yukon River	41,399	1,187	Sand and gravel.
Undistributed[3]	182,588	1,227,860	
Total[4]	625,188	1,233,519	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] No production was reported in the Alaska Peninsula, Aleutian Islands, Bering Sea, and northwestern Alaska Regions.

[2] Values of petroleum and natural gas are based on an average unit price for the State.

[3] Includes gem stones, some sand and gravel, gold, silver, coal, natural gas, natural gas liquids, and petroleum for 1977 that cannot be assigned to specific regions.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Alaska business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	167.0	174.0	+4.2
Unemployment do	14.0	16.0	+14.3
Employment (nonagricultural):			
Mining do	4.0	4.5	+12.5
Manufacturing do	10.3	10.3	--
Contract construction do	30.2	20.1	-33.4
Transportation and public utilities do	15.8	15.2	-3.8
Wholesale and retail trade do	27.6	27.8	+.7
Finance, insurance, and real estate do	7.1	7.7	+8.4
Services do	28.6	27.0	-5.6
Government do	48.2	49.9	+3.5
Total nonagricultural employment do	171.8	162.5	-5.4
Personal income:			
Total millions	$4,133	$4,311	+4.3
Per capita	$10,124	$10,586	+4.6
Construction activity:			
Number of private and public residential units authorized	5,194	6,912	+33.1
Value of nonresidential construction millions	$128.7	$157.3	+22.2
Value of State road contract awards do	$111.8	$111.8	--
Shipments of portland and masonry cement to and within the State thousand short tons	134	120	-10.4
Mineral production value:			
Total crude mineral value millions	$625.2	$1,233.5	+97.3
Value per capita, resident population	$1,637	$3,031	+85.2
Value per square mile	$1,066	$2,104	+97.4

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

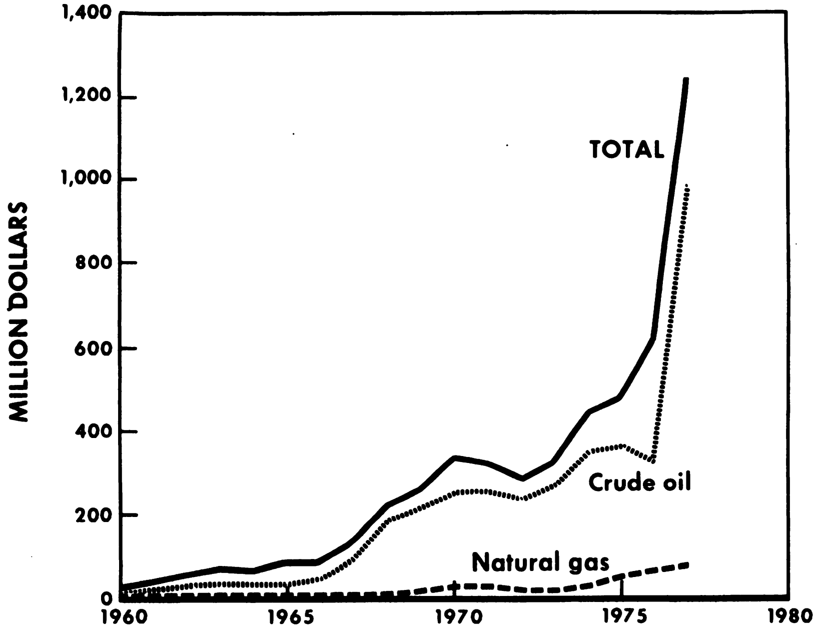

Figure 1.—Value of crude oil, natural gas, and total value of mineral production in Alaska.

The Alaska Department of Revenue reported that total net tax collections for the period July 1, 1976, to June 30, 1977, were $748.2 million, not including fish and game licenses. Mines and mining taxes contributed 0.01% of the total; the oil and gas conservation tax, 1.01%; the oil and gas production tax, 4.82%; and the oil and gas reserves tax, 38.53%.

The three-way trade of State lands in Alaska to the Federal Government in accordance with the Cook Inlet trade agreement was ruled constitutional by the U.S. Supreme Court. The ruling came as a result of appeals filed by the State of Alaska and Cook Inlet Region, Inc., protesting the 1976 State Supreme Court ruling that the trade was unconstitutional.

The Alaska Division of Land and Water Management reported on the status of land selection activity in 1977. The State of Alaska has patent to more than 21 million acres of land with an additional 15 million acres tentatively approved for patent. Approximately 73 million acres has been applied for, including territorial grants, statehood grants, and other Federal grants.

According to the DGGS, an estimated $15 million was spent on exploration in arctic Alaska in 1977. Most of the work was done in the Ambler district in the western Brooks Range. Exploration also was conducted in the area east of Selawik. A number of companies conducted exploration programs on the Seward Peninsula, spending an estimated $7 million. Several companies were working in the Nabesna, Orange Hill, and McCarthy areas in the Wrangell Mountains. Companies also were active in the Fairbanks area. Southeastern Alaska probably received the most intensive exploration activity in the State. Uranium, barite, molybdenum, and base metals were the principal targets for exploration.

Jurisdiction of the National Petroleum Reserve in Alaska (NPRA) was officially transferred to the U.S. Department of the Interior on June 1, 1977. This was in accord with Public Law 94-258, which created NPRA. Section 105(c) of the act charged the Secretary of the Interior with establishing a task force to study values and best uses of the lands contained in the Reserve. The Secretary also is responsible in the study to consider natives living on or dependent upon NPRA lands; the scenic, historical, recreational, fish and wildlife, and wilderness values; and the mineral potential and other values of these lands.

The U.S. Bureau of Mines and the U.S. Geological Survey started a joint program in 1977 to conduct a mineral resource inventory in NPRA. Work during this first field season was restricted primarily to the paleozoic rocks south of the Colville River between west longitudes 156° and 162°. Some geologic data also were collected in areas adjacent to NPRA where the information was inferred to be pertinent to the mineral resource evaluation. The investigations were limited to coal and other hard minerals. Petroleum and natural gas investigations are being conducted under contract by Husky Oil Co. The Bureau of Mines field team examined 18 separate zones or areas, including Drenchwater Creek, which contains base metal mineralization. The preliminary investigation indicated a zone 7,000 to 10,000 feet long containing two sulfide-mineral-bearing horizons.

The 10th Alaska State Legislature acted on several issues that will concern the minerals industry. The House approved legislation calling for the opening of the North Slope haul road for year-round public use. The bill bans off-road vehicles and hunting within 5 miles of either side of the road. The legislature passed AS 46.40, the Alaska Coastal Management Act of 1977, which was approved by Governor Hammond on June 3, 1977. The act created the Alaska Coastal Policy Council to direct the Coastal Management Program and resolve any problems.

Governor Hammond introduced a bill to levy a net proceeds tax on mining profits. The bill would allow a 3.5-year exemption for new producing mines, followed by a 3% tax on profits between $40,000 and $50,000, 5% on profits between $50,000 and $100,000, and about 7% on proceeds over $100,000 after certain direct expenses have been deducted.

The State legislature announced its opposition to the restrictive land classifications of the pending D-2 Land Bill that was before the U.S. Congress. SJR-12, passed by the House, reaffirmed this position, and both the House and the Senate Resources Committee discussed the D-2 question in a joint session in March. Representative Clark Gruening introduced HB-233 and HB-234, creating a task force steering committee to help consolidate Alaska positions as much as possible, lobby the issue in the U.S. Congress, and even give grants to groups that do not follow the general position of the task force.

Governor Hammond introduced HB-298, and the special House Permanent Fund Committee submitted HB-300; the nearly identical bills are aimed at management of the permanent fund. According to the bills, their purpose is to make investments that would produce income that would be used to diversify Alaska's economy, reduce the cyclical pattern of the State's economy, promote private and public capital for community purposes, encourage outside private capitalization, and supplement private capital markets when capital from private sources is scarce.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Doyon, Inc., contracted with BP Alaska Exploration, General Crude Oil Co., McIntyre Mines, Inc., Union Carbide, and Ethyl Corp. to prospect and explore for minerals on corporation lands south and west of Fairbanks. Exploration of the Eagle asbestos prospect, about 40 miles southwest of Eagle, started in 1976 and included airborne and ground magnetic surveys, geologic mapping, and drilling. Drilling, geologic mapping, and sampling continued in 1977, and preliminary indications were favorable.

Barite.—ALYU Mining Co. continued exploration and preliminary development of the Marmot mine near Haines in southeastern Alaska. The ore is barite with lead, zinc, copper, gold, and silver. The company plans to produce about 200 tons of barite per day for use in oil well drilling muds. The accompanying metals also will be recovered.

Sand and Gravel.—Production of sand and gravel in Alaska in 1977 declined 10%. A total of 66.4 million short tons was produced in 1977, compared with 74.2 million tons in 1976. The total value of production was $134.3 million, or $2.02 per unit. Thirty-nine companies operated in 1977, producing 7.2 million tons for concrete aggregate, 3.2 million tons for asphaltic concrete aggregate, 2.6 million tons for road bases, 53.1 million tons for fill, and 286,400 tons for other uses.

Stone.—Production of stone in Alaska in 1977 fell off about 40% from 1976 output.

About 85 short tons of irregularly shaped dimension stone was produced from 13 quarries at a unit value of $15.00. The crushed stone was used for concrete aggregate, 6,700 short tons valued at $13.89 per unit; bituminous aggregate, 533,300 tons valued at $2.89 per unit; dense-graded roadbase stone, 3.3 million tons valued at $4.68 per unit; surface treatment aggregate, 4,200 tons valued at $13.33 per unit; unspecified aggregate, 7,600 tons valued at $2.47 per unit; riprap-jettystone, 76,600 tons valued at $2.04 per unit; and railroad ballast, 70,000 tons valued at $2.04 per unit. A total of 4.0 million short tons valued at $17.5 million was produced from 136 quarries. The unit value for all stone produced was $4.37.

METALS

Antimony.—Prospecting for antimony, gold, silver, and lead continued on Eldorado and Caribou Creeks in the Kantishna area, Mount McKinley recording district. Alaska Milling and Metallurgical Co. was developing an antimony property in the Kantishna area.

Copper.—Only a small quantity of copper was produced in 1977, but it was one of the more active metals on the exploration scene. The Ambler River, Survey Pass, and the De Long Mountains areas in the western Brooks Range continued to be among the more active regions in the State. The Bear Creek Mining Co. exploration program at Arctic Camp continued through the 1977 season, and work was to resume in 1978. The Anaconda Company and Sunshine Mining Co. also conducted exploration work in the Ambler district. Norand Mines Ltd. also had crews examining copper-lead-zinc deposits in the Ambler River and Survey Pass region.

Other companies active in the western Brooks Range included General Crude Oil Co., BP Alaska Exploration, Placid Oil Co., Cominco American, Inc., Houston Oil and Mining Co., Canawex Mining Co., Rio Tinto Canadian Exploration, Ltd. and United States Steel Corp.

There also was considerable activity in the eastern Alaska Range in the Slana, Chisana-Horsfeld, McCarthy, and Nabesna-Orange Hill areas. Companies exploring for copper and associated minerals included Geneva-Pacific Corp., Hanna Mining Co., Inspiration Development Co., Coastal Mining Co., Talmo Mining Co., United States Borax & Chemical Corp., and Ptarmigan Mining Co. Minerals included copper, molybdenum, and silver.

There was more exploration activity in interior Alaska than in previous years. Probably the most active firm was Doyon, Inc., which had contracts with BP Alaska Exploration, General Crude Oil Co., McIntyre Mines, Inc., Union Carbide Corp., and Ethyl Corp. to explore their Regional Corporation Lands south and west of Fairbanks and in the Porcupine-Fortymile area. Falconbridge Copper, Ltd., explored for copper and silver in the Crystal Creek-Skwentna River area, and Noranda was active in the Talkeetna Mountains. General Crude and Houston Oil were looking for base metals in the Chandalar and Talkeetna areas. Cities Service Minerals Exploration, Inc. was developing a copper property in the Denali area and prospecting for gold at Gold Hill on the east slope of the Talkeetna Mountains. Placid Oil also was prospecting for zinc, copper, and molybdenum in the same area.

General Crude and Houston Oil were exploring for copper, lead, zinc, silver, and gold on Admiralty Island in southeastern Alaska. BP Alaska was prospecting for copper on La Touche Island in Prince William Sound.

Gold.—Production and value of Alaskan gold in 1977 fell off from that of 1976. Reported production was 18,962 troy ounces in 1977, compared with 22,887 troy ounces in 1976. The reported production does not reflect total output because many miners do not report their production. Estimates of actual production in the State range as high as 60,000 troy ounces. The value of 1977 production was $2.8 million. The total reported gold produced in the State from 1880 to 1977 was 30,090 million ounces.

The Alaska Gold Co. completed repairs on dredge No. 5 in the upper Dry Creek area east of Nome on May 30. The dredge is working downstream toward the third beach line. It operated on a 24-hour basis, except for normal maintenance and cleanups, until November 2. Approximately 1 million cubic yards of material was moved during this period. Major repairs were completed on dredge No. 6 during the 1976-77 winter. The dredge now has a new 145-foot digging ladder, a new bucket line, and new main drive equipment. It is capable of digging to greater depths than before it was rebuilt. This dredge started digging on July 10 and was shut down on November 1. There was considerable downtime, and only about 300,000 cubic yards of material was processed. Power for both dredges and the pumps is generated at the company power plant by two diesel generators rated at 981 kilowatts each and three solar diesel generators rated at 800 kilowatts each.

Table 4.—Alaska: Placer production of gold

Year	Mines producing	Material[1] treated (thousand cubic yards)	Gold recovered: Troy ounces	Gold recovered: Value (thousands)	Gold recovered: Average value per cubic yard
1973	23	972	7,107	$695	$0.715
1974	21	975	9,146	1,461	1.499
1975	23	1,751	14,980	2,419	1.382
1976	26	1,699	22,605	2,833	1.667
1977	22	1,800	18,924	2,807	1.559

[1] Excludes material treated primarily for the recovery of platinum.

The Alaska Gold Co. estimated there were 1.2 million troy ounces of gold contained in 124 million cubic yards of gravel. The company has control of 1,280 acres in the Nome area. During the 1976 season, the cost of recovering 1 ounce of gold was about $110.

The DGGS estimated there were about 200 small placer mining operations and 2 dredge mining operations in the State in 1977. Production was reported in the Circle-Center, Coal Creek, Manley Hot Springs, Fortymile, Boundary, Wiseman, Ruby, Flat, and Marble Creek districts in central Alaska. Production also was reported from the Candle, Nome, Bendeleban Mountains, and Imuruk areas on the Seward Peninsula. Dredge production was reported from Nome and Ungalik. Callahan Mining Corp. continued exploration and development work at Little Squaw lode mine in the Chandalar district. The Talmo Mining Co. was exploring for gold in the Wrangell Mountains, and Cities Service Minerals Exploration, Inc., reportedly was working in the Gold Hill area in the Talkeetna Mountains. Phelps-Dodge Corp. and ASARCO Incorporated were exploring for gold in southeastern Alaska.

Lead.—Exploration programs for lead and related minerals were carried on throughout the State. Cominco American, Inc., explored in several areas in the Seward Peninsula, and Kennecott Copper Corp. was active in the Ambler district. Amax Exploration, Inc. had a crew in the Porterfield Creek area in southeastern Alaska. General Crude Oil Co., Houston Oil and Mining, BP Alaska, Placid Oil Co., Phillips Petroleum Co., Phelps-Dodge, and Getty Oil Co. all were looking for lead, zinc, and copper deposits in various areas in the State.

Noranda Exploration, Inc., continued its drilling exploration program in the Greens Creek lead-zinc-copper-silver deposit on Admiralty Island. The company planned to collar an underground adit during the 1978 season.

Molybdenum.—No molybdenum was produced in Alaska in 1977, but several companies were exploring for molybdenum in south-central, southeastern, and northeastern Alaska. Hanna Mining Co. and Inspiration Development Co. were working in the Bond Creek area in the Wrangell Mountains and Ptmarmigan Mining Co. was working in the Nabesna area near Orange Hill. Placid Oil Co. was working in the Chandalar River area, and Cities Service Minerals Exploration was active south of the Fortymile district.

Most of the exploration and development work was in southeastern Alaska. United States Borax & Chemical Corp. continued exploration and development work on the large Quartz Hill molybdenum deposit near Ketchikan. Environmental groups continued to try to block construction of an access road to the mine site. The road is designed to permit transportation of large mill-size samples for testing. Development and exploration of the deposit were expected to continue in 1978. Duval Corp. and Amax Exploration also were active in southeastern Alaska. Exxon Corp. conducted a preliminary exploration program for molybdenum on Prince of Wales Island. This work also included exploration for uranium and copper. Quintana Minerals Corp., a subsidiary of Quintana Petroleum, was looking for copper and molybdenum in the Alaska Peninsula area.

Nickel.—Inspiration Development Co. continued a diamond drilling program on its nickel-copper deposit at Bohemia Basin on Chichagof Island, southeastern Alaska. No further work was done on the Nunatak nickel-copper deposit in Glacier Bay National Park.

Uranium.—Exploration for uranium continued to increase during 1977. Most of the activity was concentrated in southeastern Alaska. Several companies were actively drilling for uranium in the Bokan Mountain area, and this work is expected to continue through 1978. Occidental Minerals Corp., Cotter Corp., and Seraphim Engineering all drilled in the Bokan Mountain area. Standard Metals discovered another Bokan-type deposit near the Ross-Adams uranium mine.

United States Borax & Chemical Corp., Amoco Minerals Co., Exxon Corp., and ARCO also were active in various parts of southeastern Alaska. The Prince of Wales Island, William Henry Bay, and Boca de Quadra areas were heavily prospected for uranium. Union Carbide had crews working in the Galena and Eagle-Charley River areas in interior Alaska and in the Kigluaik Mountains in the Seward Peninsula, southwestern Alaska. Cotter Corp. also was prospecting in the Galena area, and Getty Oil Co. was in the Wood River area.

Exxon Corp., Greatland Exploration Co., Wyoming Metals, Uranerz Exploration and Mining, Ltd., and Bendix (ERDA) were looking for uranium in the Seward Peninsula, northwestern Alaska.

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[1] State Liaison Officer, Bureau of Mines, Anchorage, Alaska.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	Region
Coal: Usibelli Coal Mine, Inc	Box 3018 Fairbanks, AK 99701	Open pit	Yukon River.
Gold:			
Bliss and Sons	129 East 11th Ave. Anchorage, AK 99501	Placer-dredge	Northwestern Alaska.
Engstrom and Son Dredging Co	Box 536 Nome, AK 99762	do	Seward Peninsula.
Heflinger Mining and Equipment Co	409 Clara St. Fairbanks, AK 99701	Placer	Yukon River.
Little Squaw Gold Mining Co	Box 184 Spokane, WA 99210	Lode placer	Do.
Marvel Creek Mining Co	Nyak, AK 99642	Placer-dredge	Kuskokwim River.
Miscovich Mining Co	Box 23 McGrath, AK 99627	Hydraulic	Do.
Peters Creek Mines	700 Ash Pl. Anchorage, AK 99501	Placer	Cook Inlet-Susitna.
UV Industries, Inc	437 Madison Ave. New York, NY 10022	Placer-dredge	Seward Peninsula.
Sand and gravel:			
Alaska Brick Co	7800 Lake Otis Rd. Anchorage, AK 99507	Pit	Cook Inlet-Susitna.
Alaska Department of Highways	Box 1487 Juneau, AK 99802	Pit	Various.
Alaska General Sand and Gravel	Lake Otis Rd. Anchorage, AK 99507	Pit	Cook Inlet-Susitna.
Alaska Sand and Gravel, Inc	University Ave. Fairbanks, AK 99707	Pit	Yukon River.
Anchorage Sand and Gravel	1813 East 1st Ave. Anchorage, AK 99501	Pit	Cook Inlet-Susitna.
Baugh-Belarde	1848 Ship Ave. Anchorage, AK 99501	Pit	Do.
Castle Construction Co	8121 Sand Lake Rd. Anchorage, AK 99502	Pit	Do.
Central Construction Co., Inc.[1]	428-117 2d Ave. Seattle, WA 98101	Pit	Northwestern Alaska.
Green Associated	Pouch 85 Fairbanks, AK 99707	Pit	Southeastern Alaska.
Rogers and Babler Inc	4607 Tudor Rd. Anchorage, AK 99507	Pit	Cook Inlet-Susitna.
U.S. Bureau of Land Management	701 C St. Anchorage, AK 99513	Pit	Federal Lands in Alaska.
Vast Construction Co., Inc	Box 4-GG Anchorage, AK 99509	Pit	Cook Inlet-Susitna.
Stone:			
Burgess Construction Co	394 Hamilton Fairbanks, AK 99707	Quarry	Yukon River, and Southeastern Alaska.
Ketchikan Pulp Co	Box 1619 Ketchikan, AK 99901	do	Southeastern Alaska.

See footnote at end of table.

Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	Region
Stone —Continued			
Klatt Aggregate Inc	Lake Otis Rd. Anchorage, AK 99502	Quarry	Cook Inlet-Susitna.
LOG Logging Co	Cape Pole Ketchikan, AK 99901	do	Southeastern Alaska.
Moore Construction Co., Inc	Ketchikan, AK 99901	do	Do.
Wayne Construction Co	4100 Tongass Ave. Ketchikan, AK 99901	do	Do.
Welborn Construction Inc	Box 684 Kodiak, AK 99615	do	Kodiak.

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[1] Also stone.

The Mineral Industry of Arizona

By Joseph C. Arundale[1]

Arizona was the largest producer of nonfuel minerals in terms of value in the Nation, although at $1.6 billion the 1977 value was down slightly from the record $1.7 billion of 1976. Most of the reduced value in 1977 was accounted for by cutbacks in copper production and lower average prices for copper. Value of mineral production ranked third among the major source of Arizona income — only manufacturing and tourism exceeded it in 1977; agriculture (crops and livestock) was fourth.

Arizona produced about 62% of the Nation's copper in 1977. Ten of the 15 leading copper-producing mines in the United States in 1977 were in Arizona. The State was the second largest producer of molybdenum and silver and the fourth largest producer of gold.

The Arizona copper scene was characterized in 1977 by depressed copper markets, production curtailments, rapidly rising production costs, and labor disputes.

Table 1.—Mineral production in Arizona[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	28	$361	33	$444
Coal (bituminous) do.	10,420	W	W	W
Copper (recoverable content of ores, etc.) short tons	1,024,421	1,425,994	923,778	1,234,168
Gem stones	NA	4,000	NA	4,500
Gold (recoverable content of ores, etc.) troy ounces	102,062	12,790	90,167	13,373
Gypsum thousand short tons	139	529	187	775
Lead (recoverable content of ores, etc.) short tons	338	156	318	195
Lime thousand short tons	546	16,115	474	15,528
Molybdenum (content of concentrate) thousand pounds	31,073	89,148	34,574	120,497
Natural gas million cubic feet	262	74	240	80
Petroleum (crude) thousand 42-gallon barrels	519	2,724	427	2,243
Pumice thousand short tons	802	1,240	621	1,226
Sand and gravel do.	[3]18,131	[3]40,184	23,313	49,946
Silver (recoverable content of ores, etc.) thousand troy ounces	7,615	33,126	6,828	31,546
Stone thousand short tons	4,147	13,921	5,367	16,495

See footnotes at end of table.

Table 1.—Mineral production in Arizona[1] —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Zinc (recoverable content of ores, etc.) short tons	9,501	$7,030	4,380	$3,013
Combined value of asbestos, beryllium concentrates (1976), cement, clays (selected), feldspar, fluorspar, helium (high purity, 1976), iron ore (1976), mica (crude), perlite, pyrite, salt, sand and gravel (industrial, 1976), tungsten, and values indicated by symbol W	XX	79,229	XX	127,227
Total	XX	1,726,621	XX	1,621,256
Total 1967 constant dollars	XX	886,275	XX	[P]802,720

[P]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value." XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes certain clays; included in "Combined value."

[3] Excludes industrial sand and gravel; included in "Combined value."

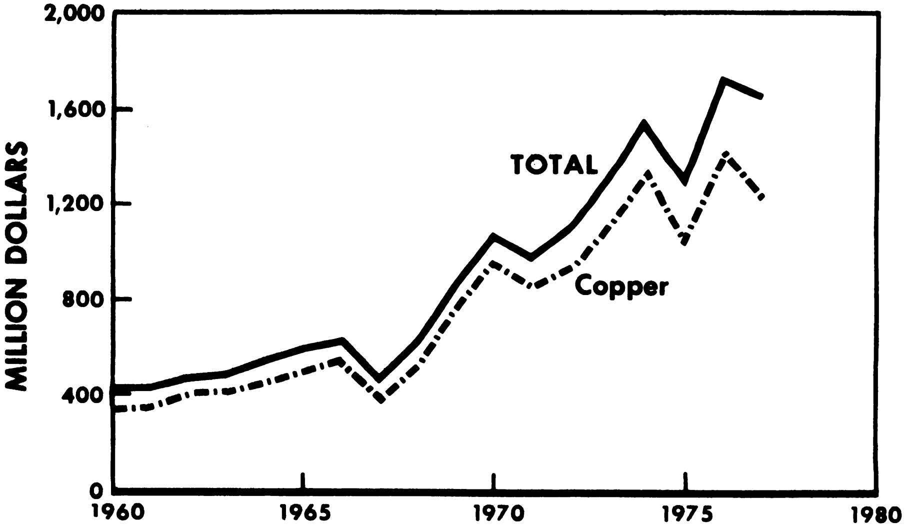

Figure 1.—Value of mine production of copper and total value of mineral production in Arizona.

Table 2.—Value of mineral production in Arizona, by county

(Thousands)

County	1976	1977	Minerals preduced in 1977 in order of value
Apache	$3,863	W	Sand and gravel, clays, pumice, stone.
Cochise	W	$24,141	Copper, lime, stone, sand and gravel, silver, gold, tungsten, lead.
Coconino	2,532	W	Sand and gravel, pumice, stone.
Gila	187,098	141,722	Copper, silver, molybdenum, gold, stone, asbestos, lime, sand and gravel, fluorspar, clays, lead.
Graham	1,021	W	Sand and gravel, copper, stone, pumice.
Greenlee	W	W	Copper, silver, gold, lime, stone, sand and gravel.
Maricopa	20,491	W	Sand and gravel, lime, salt, stone, clays.
Mohave	27,736	38,053	Copper, molybdenum, stone, silver, sand and gravel, feldspar, gold, lead, zinc.
Navajo	38,341	2,815	Sand and gravel, pumice.
Pima	680,513	629,607	Copper, molybdenum, cement, silver, sand and gravel, stone, gold, lead, clays, tungsten, zinc, mica.
Pinal	401,327	390,180	Copper, gold, silver, molybdenum, stone, sand and gravel, lime, gypsum, perlite, lead, pyrites, tungsten, clays, zinc.
Santa Cruz	600	629	Sand and gravel.
Yavapai	67,506	76,600	Copper, cement, lime, sand and gravel, stone, zinc, molybdenum, silver, gypsum, clays, gold.
Yuma	W	W	Sand and gravel, tungsten.
Undistributed[1]	295,594	317,507	
Total[2]	1,726,621	1,621,256	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes value of mineral production that cannot be assigned to specific counties, gem stones, petroleum, natural gas, coal (bituminous), and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Arizona business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	937.0	976.0	+4.2
Unemployment do	92.0	80.0	-13.0
Employment (nonagricultural):			
Mining do	24.0	21.8	-9.2
Manufacturing do	105.6	112.0	+6.1
Contract construction do	41.5	48.9	+17.8
Transportation and public utilities do	39.5	41.1	+4.0
Wholesale and retail trade do	183.8	193.6	+5.3
Finance, insurance, real estate do	42.6	45.0	+5.6
Services do	144.4	152.1	+5.3
Government do	177.3	182.2	+2.8
Total nonagricultural employment do	758.7	796.7	+5.0
Personal income:			
Total millions	$13,370	$14,943	+11.8
Per capita	$5,944	$6,509	+9.5
Construction activity:			
Number of private and public residential units authorized	23,963	41,913	+74.9
Value of nonresidential construction millions	$585.3	$314.0	-46.4
Value of State road contract awards do	$120.0	$140.0	+16.7
Shipments of portland cement to and within the State thousand short tons	1,111	1,477	+32.9
Mineral production value:			
Total crude mineral value millions	$1,726.6	$1,621.3	-6.1
Value per capita, resident population	$761	$706	-7.2
Value per square mile	$15,158	$14,233	-6.1

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Trends and Developments.—Local concern focused on the role of Arizona copper in the evolving international copper situation. Specifically, expansion of copper-producing facilities worldwide, buildup of world inventories, rapidly escalating domestic costs, and economic and political situations in many foreign copper-producing countries raised serious questions about the ability of domestic producers to continue to compete.

The increase of laws and regulations that tend to restrict land use and reduce the availability of land for exploration and development of minerals was a growing concern, and debate on the advisability, need, and consequences was stepping up in Arizona because of the impact of minerals activity on the economy of the area.

Much of the mineral resource base of the State is on Indian reservations. In 1977 there was growing evidence of Indian involvement with their resources and hope for greater independence, sovereignty, and economic benefits based on them. Exploration, evaluation, and development of mineral resources on the reservations were becoming more prominent aspects of Indian plans and programs.

Water — a precious commodity and a vexing problem in the Southwest — was in the forefront of trends and developments in Arizona in 1977. Water rights, water supplies and availability, water uses and conservation, water quality, and all their ramified aspects, were being defined as issues that will largely determine the future industrial and social condition of the State.

Development work was continued at Phelps Dodge Corp.'s deep ore body at Safford, where $9.6 million was spent in 1977. This is part of a long-term program, and no decision has been made as to when to bring the property into production.

No further development work was done during 1977 on Phelps Dodge's Copper Basin property southwest of Prescott.

Employment and Injuries.—Officials of 25 unions representing copper workers in Arizona began early in the year preparing new contract bargaining positions and proposals. Income security, higher wages, and increased cost of living allowances were reportedly the union's principal objectives in the 1977 negotiations.

Union demands, record inventories of unsold copper, lower prices, and soaring costs culminated in a general strike of copper workers at the end of June, and by the end of August nearly one-third of Arizona's 25,500 copper workers were out of work. This included about 6,300 layoffs and about 1,200 still on strike at ASARCO Incorporated operations.

Following the strikes, new 3-year agreements, expiring June 30, 1980, were entered into at Phelps Dodge operations covering employees at Arizona mines and smelters. These agreements, after taking into account cost-of-living adjustments and assuming a 7% annual rate of inflation, are expected to result in an average annual increase of about 8.3% in total labor costs at the facilities covered by the agreement.

Table 4.—Major sources of income in Arizona[1]

(Millions)

Source of income	1976	1977	Change, percent
Manufacturing (value added)	$3,000	$3,380	+12.7
Mining[2]	1,727	1,621	-6.1
Tourism	2,625	2,885	+9.9
Livestock	538	509	-5.4
Crops	702	690	-1.7

[1] Valley National Bank, Research Department, Phoenix, Ariz.

[2] U.S. Bureau of Mines.

Table 5.—Valuation on centrally assessed groups of property in Arizona[1]

(Millions)

Group	1976	1977	Change, percent
Utilities	$1,378.7	$1,482.0	+7.5
Mines	1,166.6	1,177.8	+1.0
Pipelines	312.3	326.8	+1.7
Railroads	140.1	150.8	+7.6
Airlines	30.1	30.2	+.3
Oil and gas	3.0	2.4	-20.0

[1] Pay Dirt, June 1977.

Environment.—Phelps Dodge Corp.'s Arizona smelters operated throughout 1977 under State regulations for sulfur dioxide emissions which, to supplement the sulfur dioxide removal system and programs employed by the smelters, included the use of intermittent controls to meet air quality standards. Using continuous predictions of air quality, these controls required the curtailment or suspension of smelter operations when necessary to maintain compliance with the standards. This resulted, particularly at Morenci, in reduced smelter availability and increased smelting costs.

Table 6.—Arizona: Worktime and injury experience in the mineral industries

Year and industry	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate
1976:						
Copper:						
Underground	4,772	9,469,514	3	0.32	452	47.31
Surface	5,912	12,580,588	2	.16	180	14.31
Shops	656	1,211,510	--	--	7	5.78
Mills	5,173	10,682,022	2	.19	189	17.69
Subtotal or average	16,513	33,943,634	7	.21	828	24.39
Office	1,926	3,655,723	--	--	3	.82
Total or average	18,439	37,599,357	7	.19	831	22.10
Other metals:						
Underground	73	32,053	--	--	--	--
Surface	9	2,675	--	--	--	--
Mills	7	2,232	--	--	--	--
Subtotal or average	89	36,960	--	--	--	--
Office	3	765	--	--	--	--
Total or average	92	37,725	--	--	--	--
Sand and gravel:						
Surface	1,080	1,445,708	--	--	9	6.23
Office	115	143,026	--	--	--	--
Total or average	1,195	1,588,734	--	--	9	5.66
Other nonmetals:						
Underground	30	11,881	--	--	1	84.17
Surface	197	239,663	--	--	7	29.21
Mills	24	29,475	--	--	1	33.93
Subtotal or average	251	281,019	--	--	9	32.03
Office	13	14,351	--	--	--	--
Total or average	264	295,370	--	--	9	30.47
Coal:						
Underground	--	--	--	--	--	--
Surface	632	1,273,417	1	.79	53	41.62
Shops	--	--	--	--	--	--
Mills	32	61,493	--	--	--	--
Subtotal or average	664	1,334,910	1	.75	53	39.70
Office	10	23,055	--	--	--	--
Total or average	674	1,357,965	1	.74	53	39.03
1977:						
Copper:						
Underground	4,312	8,315,845	3	.36	258	31.03
Surface	5,624	11,220,046	1	.09	137	12.21
Shops	568	1,060,138	--	--	12	8.49
Mills	5,055	9,405,777	--	--	133	14.14
Subtotal or average	15,559	30,001,806	4	.13	540	18.00
Office	2,036	3,924,670	--	--	1	.25
Total or average	17,595	33,926,476	4	.12	541	15.95
Other metals:						
Underground	36	18,278	--	--	--	--
Surface	14	7,178	--	--	--	--
Mills	13	7,628	--	--	--	--
Subtotal or average	63	33,084	--	--	--	--
Office	4	856	--	--	--	--
Total or average	67	33,940	--	--	--	--
Sand and gravel:						
Surface	1,243	1,505,783	2	1.33	17	11.29
Office	138	157,176	--	--	--	--
Total or average	1,381	1,662,959	2	1.20	17	9.62
Other nonmetals:						
Underground	40	41,849	--	--	1	23.90
Surface	141	232,903	--	--	8	34.35
Mills	86	103,770	--	--	4	38.55
Subtotal or average	267	378,522	--	--	13	34.34

Table 6.—Arizona: Worktime and injury experience in the mineral industries —Continued

Year and industry	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate
1977 —Continued						
Other nonmetals —Continued						
Office	24	24,623	--	--	1	40.61
Total or average	291	403,145	--	--	14	34.73
Coal:						
Underground	--	--	--	--	--	--
Surface	760	1,735,401	--	--	52	29.96
Shops	--	--	--	--	--	--
Mills	35	66,614	--	--	1	15.01
Subtotal or average	795	1,802,015	--	--	53	29.41
Office	6	23,718	--	--	--	--
Total or average	801	1,825,733	--	--	53	29.03

Source: Mine Safety and Health Administration, U.S. Department of Labor.

The Federal Environmental Protection Agency (EPA) recently promulgated its own sulfur dioxide control regulations for Arizona which would ultimately require the installation of additional facilities to remove sufficient sulfur dioxide from smelter emissions to make the use of intermittent controls unnecessary. EPA has since deferred the effective date of the new regulations, but because the three Arizona smelters of Phelps Dodge cannot comply with them in the foreseeable future, Phelps Dodge petitioned EPA to reconsider them.

Phelps Dodge's Arizona smelters are also subject to Federal and State particulate emission regulations which were suspended for administrative review. Phelps Dodge's Arizona smelters cannot fully comply with these regulations in their present form.

Water.—The 1977 session of the Arizona legislature passed a bill designed to solve immediate problems of ground-water transfer and to form a commission to develop a State ground-water management plan. A water "crisis" was created by a 1976 ruling by the Arizona Supreme Court that prohibited pumping of ground-water from one parcel of land to another — thus shutting off water supplies to the huge mining operations south of Tucson and presenting major problems for agriculture, municipalities, and other industries. The bill passed by the legislature — the first revision in Arizona ground-water law in a quarter century — allowed the mining operations and the City of Tucson to continue pumping (with a certificate of exemption from the State Land Department), but with liability for any damages. In a compromise aimed at resolving the dispute over transfer of ground water in critical areas, a 25-member Groundwater Management Study Commission was set up to write a comprehensive revision of the State's ground-water code by 1979. The commission's recommendations were to become law automatically in 1981 if the legislature failed to act on its report. The Governor named 11 persons to the commission; 2 of the appointees represented mining interests, and the other 9 represented agriculture, Indians, and the public. The other 14 members of the commission were, by law, members of the State legislature.

REVIEW BY MINERAL COMMODITIES

METALS

Copper.—Copper production was 76% of the value of the State's mineral output.

Mine production at the San Manuel mine of Magma Copper Co. continued at curtailed levels throughout 1977. For the first half of the year, mine production averaged 42,700 tons of ore per day, increasing to 52,400 tons per day in the second half when further lower grade ore was drawn from existing blocks that required no additional development. Mine development was limited essentially to that required to support current ore production, which, together with significant curtailment in employment, reduced unit costs. A limited development program was being continued to gain access for underground drilling in the adjoining Kalamazoo ore body at San Manuel. Expenditures for equipment and supplies not critical to current levels of production were deferred.

The Superior mine of Magma Copper Co. operated at capacity, 2,900 tons per day, throughout the year. The mills at Superior and San Manuel continued to treat copper-bearing smelter slag accumulated in previous years.

Technical problems at the San Manuel smelter of Magma Copper Co. that limited production in the fourth quarter of 1976 and early 1977 were remedied by the end of the first quarter, and production returned to normal by the end of April. Because of the smelter problems, it was necessary to purchase 20,240 tons of copper in the first quarter to fulfill sales commitments. Periodic curtailments of smelter production in 1977 to stay within sulfur dioxide emission limits during unfavorable atmospheric conditions resulted in some loss of production.

Table 7.—Arizona: Total value of mineral production in Arizona, and production and value of copper in Arizona and the United States

	Arizona			United States		Arizona	
		Copper production		Copper production			
Year	Total value of mineral production (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Percent of U.S. copper production	Percent of world copper production
1973	$1,304,988	927,271	$1,103,453	1,717,940	$2,044,346	54.0	11.8
1974	1,562,234	858,783	1,327,678	1,597,002	2,468,964	53.8	10.7
1975	1,288,423	813,211	1,044,162	1,413,366	1,814,763	57.5	[r]10.5
1976	1,726,621	1,024,421	1,425,994	1,605,586	2,234,975	63.8	[r]12.4
1977	1,621,256	923,778	1,234,168	1,503,966	2,009,297	61.4	10.9

[r] Revised.

Table 8.—Arizona: Fifteen leading copper-producing mines, in order of output

Rank in 1977	Rank in 1976	Mine	County	Operator	Source of copper in 1977
1	4	Twin Buttes	Pima	Anamax Mining Co	Copper ore.
2	2	San Manuel	Pinal	Magma Copper Co.	Copper ore and tailings.
3	1	Morenci	Greenlee	Phelps Dodge Corp	Copper ore, precipitates and tailings.
4	3	Sierrita	Pima	Duval Corp	Copper ore.
5	5	Ray	Pinal	Kennecott Copper Corp.	Copper ore and precipitates.
6	8	Pinto Valley	Gila	Cities Service Co.	Do.
7	6	Pima	Pima	Cyprus Pima Mining Co	Copper ore.
8	7	Metcalf	Greenlee	Phelps Dodge Corp	Copper ore and tailings.
9	10	Superior	Pinal	Magma Copper Co.	Copper ore.
10	9	New Cornelia	Pima	Phelps Dodge Corp	Do.
11	15	Bagdad	Yavapai	Cyprus Bagdad Copper Co	Do.
12	12	Mission	Pima	ASARCO Incorporated	Do.
13	16	Lakeshore	Pinal	Hecla Mining Co.	Do.
14	14	Sacaton	do	ASARCO Incorporated	Do.
15	11	Inspiration	Gila	Inspiration Consolidated Copper Co.	Copper ore and precipitates.

Table 9.—Arizona: Material handled and copper produced at fifteen leading copper open pit and underground mines

Mine	Ore mined (thousand short tons)		Waste material removed (excluding material placed in leach dumps) (thousand short tons)		Material placed in leach dumps (thousand short tons)		Total copper produced[1] (short tons)	
	1976	1977	1976	1977	1976	1977	1976	1977
OPEN PIT								
Twin Buttes	13,383	10,850	71,391	58,266	2,006	2,217	95,661	115,319
Morenci	18,705	15,727	7,020	5,504	20,957	18,283	113,067	104,621
Sierrita	34,023	29,740	50,578	47,252	--	--	101,464	88,554
Ray	9,806	10,423	--	--	25,127	26,519	86,228	85,956
Pinto Valley	15,159	13,501	--	--	26,279	23,523	66,803	60,818
Pima	19,554	14,136	39,977	22,566	--	--	77,493	55,329
Metcalf	11,328	9,810	8,641	8,609	12,144	8,689	78,190	53,749
New Cornelia	9,482	6,829	6,699	2,808	3,995	4,920	51,016	36,619
Bagdad	2,044	3,906	17,388	23,381	2,604	7,192	17,795	24,046
Mission	6,407	4,624	9,763	10,423	--	--	35,190	23,298
Sacaton	3,732	3,471	21,859	15,201	--	--	22,021	19,872
Inspiration	4,610	2,497	3,633	4,326	5,209	1,728	35,935	19,490
UNDERGROUND								
San Manuel	15,016	17,000	159	151	--	--	113,730	116,528
Superior	971	1,035	150	89	--	--	41,446	44,581
Lakeshore	2,620	2,487	332	NA	--	--	17,600	20,504

NA Not available.
[1] Gross metal content.

Table 10.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Lode mines producing[1]	Material sold or treated (short tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
1975, total	39	169,244,487	85,790	$13,854,229	6,285,854	$27,783,475
1976, total	45	195,242,151	102,062	12,790,411	7,615,112	33,125,739
1977:						
Cochise	4	1,582,480	2,032	301,366	112,516	519,824
Gila	8	22,288,245	6,434	954,227	334,190	1,543,958
Greenlee	2	25,553,851	13,973	2,072,335	784,198	3,622,995
Pima	8	75,061,603	19,076	2,829,162	3,698,715	17,088,063
Pinal	9	36,895,144	48,089	7,132,079	1,542,460	7,126,166
Yavapai	2	3,686,710	493	73,117	120,342	555,980
Undistributed[2]	2	5,906,027	70	10,382	235,724	1,089,045
Total	35	170,974,060	90,167	13,372,668	6,828,145	31,546,031

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	813,211	$1,044,162,368	420	$180,587	8,655	$6,751,054	$1,092,731,713
1976, total	1,024,421	1,425,993,666	338	155,957	9,501	7,030,387	1,479,096,160
1977:							
Cochise	9,408	12,569,554	2	1,246	--	--	13,391,990
Gila	101,617	135,760,305	--	--	--	--	138,258,490
Greenlee	152,828	204,177,573	--	--	--	--	209,872,903
Pima	348,408	465,473,050	231	141,988	9	6,056	485,538,319
Pinal	271,717	363,014,373	68	41,809	(3)	21	377,314,448
Yavapai	24,788	33,116,742	--	--	4,364	3,002,535	36,748,374
Undistributed[2]	15,012	20,056,300	16	10,060	7	4,485	21,170,272
Total	923,778	1,234,167,897	[4]318	195,103	4,380	3,013,097	1,282,294,796

[1] Operations at miscellaneous cleanups not counted as mines.
[2] Includes Graham and Mohave Counties combined to avoid disclosing company proprietary data.
[3] Less than 1/2 unit.
[4] Data do not add to total shown because of independent rounding.

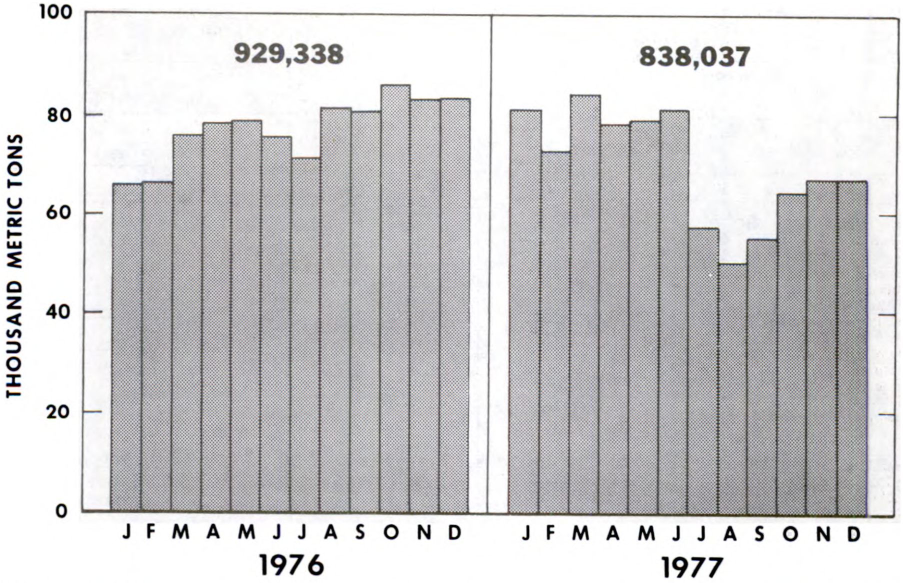

Figure 2.—Mine production of copper in Arizona, by month, in terms of recoverable metal.

Table 11.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Silver	4	18,337	2,036	117,467	12	2	--
Copper	25	168,600,691	87,720	6,680,543	851,192	258	15
Copper-zinc	1	40,710	154	15,872	1,429	--	4,364
Total[2]	26	168,641,401	87,874	6,696,415	852,620	258	4,380
Other lode material:							
Gold-silver tailings, copper cleanup, and copper tailings[3]	5	[4]2,256,319	257	14,263	25,217	58	--
Copper precipitates	11	58,003	--	--	45,929	--	--
Total	16	2,314,322	257	14,263	71,146	58	--
Grand total[2]	35	170,974,060	90,167	6,828,145	923,778	318	4,380

[1] Detail will not add to total because some mines produce more than one class of material.

[2] Data may not add to totals shown because of independent rounding.

[3] Combined to avoid disclosing company proprietary data.

[4] Excludes newly generated tailings.

Table 12.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Cyanidation	1,900	77,000	--	--	--
Acid leaching (vat, tank, heap)[1]	--	--	117,069	--	--
Smelting of concentrates	87,842	6,695,008	759,825	251	4,380
Direct smelting of:					
Ore	168	41,874	593	9	--
Precipitates	--	--	45,929	--	--
Tailings[2]	257	14,263	363	58	--
Total	425	56,137	46,885	67	--
Grand total	90,167	6,828,145	[3]923,778	318	4,380

[1] Includes copper recovered by electrowinning process.
[2] Includes miscellaneous copper cleanup.
[3] Data do not add to total shown because of independent rounding.

Excess inventories of copper concentrates accumulated in late 1976 and early 1977 were smelted by yearend.

In midyear, Magma undertook conversion of its reverberatory furnaces to burn coal as a primary fuel. The conversion was expected to be completed in 1979 at an estimated cost of $25 million.

New 3-year labor contracts expiring July 1, 1980, were negotiated without a strike with unions representing Magma employees.

Inspiration Consolidated Copper Co. is an integrated natural resources company. Its principal business is the production and sale of copper from its Arizona operations, which include mines, smelter, refinery, and rod-fabricating and sulfuric acid plants. Inspiration also smelts copper-bearing materials for other producers. All of Inspiration's Arizona operations were shut down by a strike which began on July 1 and ended August 26. Following the strike, operations resumed at the smelter, refinery, and rod-fabricating and sulfuric acid plants. Recovery of copper by leaching at the Ox Hide mine resumed in October. The mines and other treatment plants remained shut down for the balance of the year. The Christmas and Ox Hide open pit mines and dump leaching operations at Inspiration remained closed, pending an improvement in the price of copper.

During the first half of 1977, ore output from Inspiration's Thornton, Red Hill, and Joe Bush open pit mines averaged 19,660 tons per operating day. In addition, 47,673 tons of waste was removed per day, resulting in a waste-to-ore ratio of 2.4 to 1. Comparable figures for 1976 were 19,051 tons per day of ore, 36,534 tons per day of waste, and a waste-to-ore ratio of 1.9 to 1. A 17-cubic-yard electric shovel was ordered for delivery early in 1978. This acquisition will replace four smaller, less efficient units and reduce loading costs.

Leaching of mineralized waste dumps produced 10.7 million pounds of copper during the first half of 1977 but was suspended for the balance of the year. Production of copper from the Ox Hide open pit mine and heap-leaching operation decreased from 7.9 million pounds in 1976 to 4.6 million pounds in 1977. The leaching plant produced 13.7 million pounds of copper during its 6 months of operation, 52% in the form of electrowon cathodes and 48% as cement copper. In the same period, production of Inspiration's patented upgraded cement copper set a record. After the strike, Ox Hide provided the only source of cement copper for this operation. Production for the year was 3.1 million pounds, compared with 4.0 million pounds in 1976.

The concentrator at Inspiration treated 18,957 tons of ore per operating day in 1977, compared with 18,084 tons per day in 1976. Copper recovery improved as a result of the application of a new reagent to the flotation process.

Inspiration's rod plant produced more continuous-cast copper rod in strike-shortened 1977 than in the entire preceding year, 75.6 million pounds versus 68.7 million. Production records for pounds of rod produced per shift, per week, and per single continuous run were achieved during the year.

Copper production in the smelter's 10 months of operation was 116,000 tons, down only 9% from the 127,000 tons produced in the strike-free preceding year. Toll treatment of material from other producers' mines constituted 69% of total treatment in 1977 and 71% in 1976. Sulfuric acid production, also for 10 months, amounted to 200,000 tons in 1977, compared with a record 237,000 tons in 1976.

At the refinery, production of electrorefined cathodes dropped from 93.4 million pounds in 1976 to 89.5 million pounds in the 10 operating months of 1977. Titanium blanks are being introduced to improve the plating and stripping of starting sheets and increase cathode production.

The Christmas mine and concentrator of Inspiration operated on a 7-day-week schedule until halted by the strike. Operations remained closed through the remainder of 1977 pending improvement in copper markets. When it was operated, the mine produced 5,338 tons of ore per day, compared with 5,525 tons per day in 1976. Waste removal increased from 17,043 tons per day in 1976 to 23,498 tons per day in 1977.

On January 12, 1977, The Anaconda Company was merged into a wholly owned subsidiary of Atlantic Richfield Co., which had previously (March 31, 1976) acquired 27% of Anaconda common stock.

Anamax Mining Co., a partnership in which Anaconda and a subsidiary of AMAX, Inc., each hold 50% interest, operates the Twin Buttes open pit mine in Pima County. This mine produces both oxide and sulfide ores. Sulfide ore is concentrated and shipped to other locations for smelting into anode copper. Oxide ore is processed into cathode copper in an adjacent leaching and electrowinning plant.

Anamax also controls ore reserves under a lease from the State of Arizona. This deposit, the Palo Verde, is located about 6 miles north of the Twin Buttes mine, adjacent to a mine owned by ASARCO Incorporated. An agreement with ASARCO provides for mining the deposit. Shipment of ore to Anamax was expected to commence in late 1978.

Mining operations at the Bluebird mine of Ranchers Exploration and Development Corp. near Miami were curtailed during 1977 because of copper market conditions. Approximately 3 million tons of ore and 5,265,000 tons of waste were mined. Grade of ore was 0.79% copper. The solvent extraction-electrowinning plant produced nearly 18 million pounds of cathodes during 1977, an increase of 9% over that of 1976. Prior to curtailment, the mine was producing about 42,000 pounds of cathode copper per day. Production was expected to continue to decline, although removal of overburden continued in order to allow resumption of mining operations if the price of copper improved.

Duval Corp.'s largest mine, the Sierrita property near Tucson, began operations in 1971. Duval's Esperanza property, which is adjacent to Sierrita, has been in production since 1959, while Duval's Mineral Park property, located near Kingman, has been in production since 1964.

As a result of depressed market conditions for copper in 1977, which created an accumulation of inventory, Duval ceased production for 6 weeks in late summer of 1977 at all of its copper mines. Operations at the Esperanza property remained suspended for the remainder of 1977.

Duval operates concentrating mills at each of its copper mines for recovery of copper by flotation. During the 5 years ending December 31, 1977, Duval's production of copper contained in concentrates represented an average concentrate recovery of 86% of the copper assay content of all ore milled. Copper is also produced from supplemental leach-precipitation operations at the mines (except Sierrita).

Duval's copper concentrates and precipitates are currently sold as such, processed at Duval's CLEAR-process hydrometallurgical plant, or toll-smelted and refined by others for redelivery to and marketing by Duval. The CLEAR-process hydrometallurgical plant, located near the Sierrita property, produces copper crystals (equivalent to a high-grade blister copper) electrolytically from concentrates produced at the Esperanza and Sierrita properties and precipitates produced at the Esperanza and Mineral Park properties. The patented CLEAR process is designed to create no solid, liquid, or gaseous pollution. The plant is designed to produce 40,000 metric tons of copper crystals per year, and in 1977 was operating at about 85% of design capacity. The copper crystals are either sold as such to conventional electrolytic copper refiners and fabricators or toll-refined by others for marketing by Duval.

Production from the Lakeshore mine, jointly owned by Hecla Mining Co. and El Paso Natural Gas Co., was suspended early in September 1977 because of financial losses resulting from low copper prices and a buildup of inventories of cement copper precipitates resulting from strikes at receiving smelters.

Gold.—Production of gold, largely as a byproduct of copper production, decreased to 90,167 troy ounces from 102,062 troy ounces in 1976, but price increases brought total value up from $12.8 million to $13.4 million.

Molybdenum.—Output of molybdenum in Arizona continued to increase and reached a record tonnage. All production of molybdenum in the State is a byproduct of copper ore mining and concentration. The increase in molybdenum production at the same time copper production was decreasing was attributable to greatly improved recovery in the concentration process.

Duval Corp. is the largest producer of molybdenum in Arizona. Most of Duval's molybdenum concentrates are treated by Duval for marketing as molybdenum sulfide or for roasting in Duval's roasters to molybdenum trioxide. The balance of the molybdenum concentrates is converted into ferromolybdenum, one of a broad line of products offered to the steel and foundry industries. In 1975, Duval completed new facilities adjacent to the Esperanza property for producing ferromolybdenum in the domestic market. This plant, which cost approximately $2 million, is designed to produce 3.5 million pounds of ferromolybdenum annually.

Silver.—As a byproduct, silver followed the reduction in copper ore production in 1977 and dropped 10%. The State continued to rank second in the Nation as a silver producer, with nearly 7 million ounces valued at $31 million.

Zinc.—Most of the zinc produced in Arizona in recent years has been from the Bruce mine in Yavapai County. This mine ceased production at midyear, reportedly because of economics and depleted reserves.

NONMETALS

Production of major nonmetals in the State mostly increased in quantity and value from that of 1976.

Asbestos.—Production of chrysotile asbestos in 1977 dropped to nearly half that in 1976. The only active asbestos mine in the State was operated by Jaquays Mining Corp. in Gila County. This underground mine reported increasing costs, labor shortages, and technical problems as reasons for decreased output in 1977.

Cement.—A cement shortage began to develop in the State, and portland cement production was pushed up to capacity at Arizona's two cement plants.

Clays.—Eight companies produced a record tonnage of clays in Arizona in 1977.

Gypsum.—Production of gypsum continued to respond to increased building and construction activity in the area.

Lime.—Because of lime's use in copper ore processing, the lime industry cut back slightly in response to decreasing copper production.

Sand and Gravel.—Construction and building activity in Arizona, recovering from a low period in 1975, continued to require increasing quantities of sand and gravel.

Table 13.—Arizona: Sand and gravel sold or used by producers, by use

Use	1977 Quantity (thousand short tons)	1977 Value (thousands)	1977 Value per ton
Construction:			
Sand	7,531	$17,288	$2.30
Gravel	14,700	31,777	2.16
Total or average	22,231	49,064	2.21
Industrial sand	82	881	10.74
Grand total[1] or average	22,313	49,946	2.24

[1] Data may not add to totals shown because of independent rounding.

Table 14.—Arizona: Construction sand and gravel sold or used, by major use catagory

Use	1977 Quantity (thousand short tons)	1977 Value (thousands)	1977 Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	6,736	$17,543	$2.60
Concrete products (cement blocks, bricks, pipe, etc.)	601	1,614	2.69
Asphaltic concrete aggregates and other bituminous mixtures	3,911	10,259	2.62
Roadbase and coverings	6,744	12,250	1.82
Fill	3,346	4,860	1.45
Other uses	894	2,539	2.84
Total[1] or average	22,231	49,064	2.21

[1] Data may not add to totals shown because of independent rounding.

Table 15.—Arizona: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976 Quantity	1976 Value	1977 Quantity	1977 Value
Flux stone	1,075	3,482	825	3,031
Lime manufacture[2]	898	3,472	812	3,330
Roadstone	65	150	791	1,666
Bituminous aggregate	W	W	81	236
Manufactured fine aggregate[3]	92	318	8	161
Dense-graded roadbase stone	W	W	7	16
Refractory stone	5	W	W	W
Surface treatment aggregate	W	W	1	4
Mineral food	1	22	1	25
Terrazzo and exposed aggregate	133	540	--	--
Other uses[4]	1,871	5,842	2,833	7,898
Total[5]	4,142	13,826	5,359	16,367

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, sandstone, granite, traprock (1976), miscellaneous stone, and marble.

[2] Includes "Sugar refining."

[3] 1976 data include concrete aggregate (coarse).

[4] Includes stone used for cement manufacture, railroad ballast, filter stone, roofing granules, sulfur dioxide removal, macadam aggregate, acid neutralization (1976), agricultural limestone (1976), other uses, and uses indicated by symbol W.

[5] Data may not add to totals shown because of independent rounding.

MINERAL FUELS

Coal (Bituminous).—Coal output continued to rise slowly as Peabody Coal Co. tried to expand output at the only two coal mines in the State — Black Mesa mine and Kayenta mine. These two surface mines are on lands leased from the Navajo and Hopi Tribes. Coal from these mines is rated at about 11,000 Btu with an ash content of 8% and sulfur content of about 0.5%. Coal from the Kayenta mine goes by electric unit train to the Havajo powerplant at Page, operated by the Salt River Project. Black Mesa mine coal is pumped through a 273-mile pipeline to the Mohave generating station on the Colorado River in southern Nevada.

Natural Gas.—A small quantity of natural gas from wells in Apache County was sold to El Paso Natural Gas Co. and fed into its pipeline.

Petroleum.—Output of petroleum continued its steady decline in the State. A total of 427,000 barrels was produced in 1977 compared with 519,000 barrels in 1976 and 635,000 barrels in 1975.

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[1] State Liaison Officer, Bureau of Mines, Phoenix, Ariz.

Table 16.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos: Jaquays Mining Corp	1219 South 19th Ave. Phoenix, AZ 85009	Underground mine and crushing, screening, and air-separation plant.	Gila.
Cement:			
Arizona Portland Cement Co.,[1] a division of California Portland Cement Co.	General Delivery Rillito, AZ 85246	Quarry and plant	Pima.
Phoenix Cement Co., a division of Amcord, Inc.	3550 North Central Ave. Room 1501 Phoenix, AZ 85012	do	Yavapai.
Clays: Filtrol Corp	Box 155 Sanders, AZ 86512	do	Apache.
Copper:			
The Anaconda Company, Natural Resources Div.	Box 27007 Tucson, AZ 85726	Office and research	Pima.
Anamax Mining Co.[2] [3]	Box 127 Sahuarita, AZ 85629	Open pit and underground mines and plant.	Do.
ASARCO Incorporated:			
Hayden unit	Box 98 Hayden, AZ 85235	Smelter	Do.
Mission unit[2] [3]	Box 111 Sahuarita, AZ 85629	Open pit mine and mill	Do.
Sacaton unit[3]	Box V Casa Grande, AZ 85222	do	Pinal.
San Xavier unit[3]	Box 111 Sahuarita, AZ 85629	Open pit mine	Pima.
Silver Bell unit[3]	Silver Bell, AZ 85270	Open pit mine, mill, leach dumps, and precipitation plant.	Do.
Cities Service Co., Miami Copper Co. Div.[2]	Box 100 Miami, AZ 85539	Open pit mine, mill, leach dumps, and in-place leaching and precipitation plants.	Gila.
Continental Copper Co	Box 662 Oracle, AZ 85623	Underground mine	Do.
Continental Oil Co	Box 649 Florence, AZ 85232	Mine	Do.
Cyprus Mines Corp.:			
Cyprus Bagdad Copper Co.[4]	Box 245 Bagdad, AZ 86321	Open pit mine and mill	Do.
Cyprus Bruce Copper & Zinc Co.[4]	Box 744 Florence, AZ 85232	Underground mine and mill	Do.
Cyprus Johnson Copper Co	Drawer R Benson, AZ 85602	Open pit mine and mill	Cochise.
Cyprus Pima Mining Co.[4]	Box 7187 Tucson, AZ 85713	do	Pima.
Duval Corp.:			
Esperanza and Sierrita properties.[2] [3]	Box 125 Sahuarita, AZ 85629	Open pit mines, mills, leach dumps, and precipitation plant.	Do.
Mineral Park property[2] [3]	Box 1271 Kingman, AZ 86401	do	Mohave.
Hecla Mining Co.:			
Lakeshore mine	Box 493 Casa Grande, AZ 85222	Underground mine and plant	Pinal.

See footnotes at end of table.

Table 16.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Copper —Continued			
Inspiration Consolidated Copper Co. [2]	Inspiration, AZ 85377	Open pit mine, mill, vat leaching plant, electrowinning plant, in-place leaching, heap leaching, precipitation plant, rod plant, rolling mill, custom smelter, and electrolytic refinery.	Gila.
Christmas mine	do	Open pit mine and concentrator	Do.
Ox Hide mine	do	Open pit mine	Do.
Kennecott Copper Corp., Ray Mines Div.[2]	Hayden, AZ 85235	Open pit mine, precipitation, vat leaching, electrowinning plants, and smelter.	Do.
Magma Copper Co.:			
San Manuel Div.[1] [2] [3]	Box M San Manuel, AZ 85631	Underground mine, mill, smelter, and refinery.	Pinal.
Superior Div.[3]	Box 37 Superior, AZ 85273	Underground mine and mill	Do.
Phelps Dodge Corp.:			
Copper Queen branch[5]	Drawer K Bisbee, AZ 85603	Open pit mine, underground mine, mill, leach dumps, and in-place leaching and precipitation plant.	Cochise.
Douglas Reduction Works	Drawer E Douglas, AZ 85607	Smelter	Do.
Morenci and Metcalf branches[3]	Morenci, AZ 85540	Open pit mines, mill, leach dumps, and precipitation plant.	Greenlee.
New Cornelia branch[3]	Drawer 9 Ajo, AZ 85321	Open pit mine, mill, and smelter	Pima.
Safford branch	Box 151 Safford, AZ 85546	Underground mine	Graham.
Producers Mineral Corp.:			
Peacock mine	Box 226 North San Juan Road Safford, AZ 85546	Open pit mine, dump, and plants	Do.
Ranchers Exploration and Development Corp., Bluebird mine.	Box 880 Miami, AZ 85539	Open pit mine, leach dump, solvent extraction plant, and electrowinning plant.	Gila.
Feldspar: Arizona Feldspar Corp	Box 229 Kingman, AZ 86401	Underground mine, mill	Mohave.
Fluorite: Tonto Mining and Milling Co.	Box 275 Tonto Basin, AZ 85553	Mine, mill, and plant	Gila.
Gold:			
Magma Copper Co.:			
San Manuel Div	Box M San Manuel, AZ 85631	*See* Copper	Pinal.
Superior Div	Box 37 Superior, AZ 85273	do	Do.
Phelps Dodge Corp.:			
Copper Queen branch	Drawer K Bisbee, AZ 85603	do	Cochise.
Morenci and Metcalf branches	Morenci, AZ 85540	do	Greenlee.
New Cornelia branch	Drawer 9 Ajo, AZ 85321	do	Pima.
Gypsum:			
National Gypsum Co	Star Route, Box 89 Winkelman, AZ 85292	Open pit mine and plant	Pinal.
Pinal-Mammoth Gypsum	2020 South 9th St. Coolidge, AZ 85228	Mine	Do.
Superior Companies[5]	2402 South 19th Ave. Phoenix, AZ 85009	Quarries and plant	Pinal and Yavapai.
Lime:			
Amstar Corp	11800 E. Riggs Rd. Chandler, AZ 85224	Kiln	Maricopa.
Can-Am Corp., Paul Lime Div	Drawer T Douglas, AZ 85607	5 rotary-kiln plants	Cochise.
The Flintkote Co., U.S. Lime Div	Box 197 Peach Springs, AZ 86434	Nelson quarries and plant	Yavapai.
Kennecott Copper Corp., Ray Mines Div.	Hayden, AZ 85235	Kiln	Gila.
Phelps Dodge Corp., Morenci branch.	Morenci, AZ 85540	Rotary kiln and fluidized-bed-kiln plant.	Greenlee.
Mica: Buckeye Mica Co	Box 416 Buckeye, AZ 85326	Mine and mill	Maricopa.
Perlite:			
Filters International, Inc	Box Z Superior, AZ 85273	Open pit mine and plant	Pinal.
Guzman Construction Co	Box 7 Superior, AZ 85273	do	Do.
Harborlite, Inc	Box 960 Superior, AZ 85273	do	Do.
Pumice and volcanic cinder:			
Flagstaff Cinder Sales, Inc	Box 2796 4400 Nyla Flagstaff, AZ 86001	Quarry	Coconino.
Superlite Builders Supply, Inc	5201 North 7th St. Phoenix, AZ 85014	Open pit mine	Do.

See footnotes at end of table.

Table 16.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Quartz: Hemphill Brothers, Inc	Box 384 Kingman, AZ 86401	Open pit mine	Mohave.
Salt: Southwest Salt Co	Box 1237 Litchfield Park, AZ 85340	Brine from wells	Maricopa.
Sand and gravel: Arizona Silica Sand Co.	Box 108 Houck, AZ 86506	Open pit mine and plant	Apache.
Silica flux:			
Copper Hill Mine	Box 752 Globe, AZ 85501	Mine	Gila.
Denning Mining Co	Why, AZ 85321	Open pit mine	Pima.
Gilbert Construction Co	204 E. Vista Warren, AZ 85603 Box 5288 Bisbee, AZ 85603	Quarry	Cochise.
Little Hill Mines, Inc	Box 332 Oracle, AZ 85623	Open pit mine	Pinal.
McFarland-Hullinger	Box 811 Tucson, AZ 85702	Plant and quarry	Gila.
Gordon Wainwright-Contractor	Box G Hayden, AZ 85235	Open pit mine	Do.
O. Brice Willis	Box 1325 Clifton, AZ 85533	do	Greenlee.
Stone:			
Dunbar Stone Co	Box 246 716 Lewis Ashfork, AZ 86320	Quarries	Coconino and Yavapai.
Valley Stone Supplies	Box 372 Paulden, AZ 86334	Quarry	Yavapai.
Western States Stone Co	Box 316 Ashfork, AZ 86220	Quarries and plant	Coconino, Mohave, Yavapai, Yuma.

[1] Also lime.
[2] Also molybdenum.
[3] Also silver.
[4] Also molybdenum and zinc.
[5] Also clays, diatomite and limestone.

The Mineral Industry of Arkansas

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Arkansas Geological Commission, under a Memorandum of Understanding for collecting information on all minerals except fuels.

By Raymond B. Stroud[1]

Arkansas' versatile mineral industry accounted for $574.5 million in 1977 as the result of production of crude metallic ores, industrial minerals and rocks, and mineral fuels. This total was about 7% greater than that reported in 1976; therefore, a new record high was achieved. Production of mineral fuels accounted for the major part of the State's total mineral value largely because of the increasing prices for energy minerals. Arkansas ranked 25th in the United States in terms of mineral output value and led the Nation in production of bauxite, bromine, and vanadium.

Only 5 of the 18 mineral commodities produced in Arkansas had lower values than those reported in 1976. There was no output of phosphate rock. Carbon black, elemental sulfur, and gallium were also produced in the State, but the value of these minerals was not included in the State's total. Petroleum again led all others in value. Bromine continued to be the most significant industrial mineral produced, and vanadium oxide was Arkansas' most important metallic mineral based on value.

Mineral fuels, as expected, gained individually in value. Petroleum led all others in this segment of mineral output as well as statewide in value. Crude oil output was the highest level since 1967, exceeding 20 million barrels; value of the commodity at $200.6 million far exceeded all others. Bituminous coal output and value in 1977 increased 5% and 11% respectively. Natural gas and natural gas liquids comprised the remaining energy minerals produced in the State. Although the volume of natural gas production was lower, the value was higher than in 1976; natural gas liquids volume decreased but value increased about one-third.

The Arkansas bromine industry accounted for more than 80% of the Nation's supply of bromine, and the commodity was the State's second most significant mineral in value terms. Other industrial minerals - clays, including kaolin, lime, cement, stone, barite, sand and gravel, soapstone, gypsum, natural abrasives and tripoli - were also important mineral commodities.

Gem stones including diamond were produced at about the same level as in 1976. Quartz crystals, aggregating about 606,000 pounds, were used mainly to produce synthetic quartz for electronic applications.

Bauxite, alumina, and aluminum production comprised a substantial part of the metals industry in Arkansas. Gallium produced in conjunction with conversion of bauxite to alumina was also significant. The State's vanadium oxide output was at a reduced level but Arkansas continued as the leading vanadium-producing State in the Nation. Scattered exploration for zinc minerals continued in north Arkansas.

Trends and Developments.—Construction of two coal-fired, 700 megawatt, electric generation units at Redfield, Jefferson County, was resumed in June 1977, following a nearly 2 year recess. Arkansas Power & Light Co., the builder of this new operation, secured an increase in retail rates from the Arkansas Public Service Commission (PSC) and made other financial arrangements which allowed construction to resume. The $578 million project will consume about 5 million tons of Wyoming coal annually to fuel the plant that is rated at 1,400 megawatts. Unit 1 of the facility is scheduled to start up in 1980. The utility company, largest producer of electric power in the State, continued construction activities at unit 2, a 912-megawatt generating plant at its Nuclear One Station at Russellville. The nuclear-powered plant will have an installed capacity of about 1,760 megawatts when both units of the plant are fully operational. The second unit was scheduled for complete operation by yearend 1978. Unit 1 of this facility has operated since December 1974 and had generated, to yearend 1977, 13.6 million megawatts of electricity resulting in an estimated saving of 22 million barrels of fuel oil. In December 1977, the utility company applied for a permit from the Arkansas PSC for construction of a two-unit, 1,400-megawatt plant to be built at Newark, Independence County. This facility, estimated to cost $672 million, would be similar to the Redfield units. Coal from Wyoming would be used for fuel.

Table 1.—Mineral production in Arkansas[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives, whetstones short tons	497	$264	W	W
Bauxite thousand long tons	1,667	24,481	1,676	$24,851
Clays thousand short tons	1,047	3,396	988	5,407
Coal (bituminous) do	534	19,310	563	21,431
Gem stones	NA	85	NA	85
Lime thousand short tons	182	4,900	152	4,552
Natural gas million cubic feet	109,533	58,052	104,096	60,896
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels	203	1,422	555	5,152
LP gases do	408	2,440		
Petroleum (crude) do	18,097	174,636	20,202	200,606
Sand and gravel thousand short tons	[2]14,736	[2]25,848	16,110	36,091
Stone:				
Crushed do	17,701	39,713	18,310	45,448
Dimension do	W	W	13	368
Combined value of barite, bromine, cement (masonry and portland), gypsum, phosphate rock (1976), soapstone, sand and gravel (industrial, 1976), tripoli, vanadium, and values indicated by symbol W	XX	[r]182,480	XX	169,582
Total	XX	[r]537,027	XX	574,469
Total 1967 constant dollars	XX	275,656	XX	[p]283,558

[p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company propietary data; value included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes industrial sand and gravel; value included in "Combined value" figure.

Southwestern Electric Power Co. (SWEPCO) and Arkansas Electric Cooperative Corp. (AECC), as partners, continued construction of a coal-fired steam electric plant at Gentry. This $101 million plant was scheduled for operation in 1978 and was to have an installed capacity of 528 megawatts. Wyoming coal would be used as fuel at an annual rate of 1.75 million tons.

Reports by the U.S. Army Corps of Engineers indicated a total of 9.1 million tons of commodity shipments on the Arkansas River Waterways System. The tonnage was a 44% increase over that of 1976 and established a new record high. Shipments of minerals, mineral products, and chemicals comprised 83.4% of the total tonnage barged in 1977. Sand and gravel led with 2.7 million tons, followed by petroleum products with 1.9 million tons, and bauxite with 0.6 million tons. The bauxite was destined for use by the Arkansas mineral industry. About 600,000 tons of coal was shipped downstream to markets out of State.

The Arkansas Industrial Development Commission reported that 5,258 new jobs were created in the State in fiscal year 1976-77, an increase of about 550 jobs over the previous year. New plants and expansions to other manufacturing industries accounted for the employment rise. More than $102 million in capital investment was recorded.

The Arkansas State Chamber of Commerce reported in its 27th Annual Inventory of Industrial Growth that nearly $1 billion was spent for business and industrial purposes in the State in 1977, a new record high. Expenditures for utilities, transportation, communications, and cooperatives totaled $413.3 million. Industries in the State included Nekoosa Edwards Papers, Inc., which announced a $175 million expansion program; International Paper Co., which proposed to spend $30 million for a new forest products facility; and Reynolds Metals Co., which planned a $39 million expansion. About 40 new plants would utilize minerals and mineral products. Other well-known mineral industries that announced expansions were The Dow Chemical Co., Ethyl Corp., and Velsicol Chemical Corp. - all bromine producers - and Acme Brick Co. and Sheridan White Rock Co. Investments by these companies were to exceed $45 million.

In 1977, Allied Chemical Corp. purchased the agricultural fertilizer plant of Gardinier Big River, Inc., at Helena. The Helena plant produces anhydrous ammonia and sulfuric and phosphoric acids. Gardinier purchased the facility in 1974 from Arkla Chemical Corp., a subsidiary of Arkansas Louisiana Gas Co.

The Gould battery manufacturing plant at Fort Smith signed a $40 million contract with Western Electric Co., Inc. to provide a new long-life battery for use in the telephone communications system. The 335-pound batteries will have a life expectancy of between 30 and 100 years and will replace conventional cells that normally last about 15 years.

Rangaire Corp. announced plans for installation of a new lime kiln 287 feet long and 9.5 feet in diameter at its Batesville White Lime plant in Independence County. The new kiln, to be completed for operation in 1979, will be equipped to burn coal. The capacity of the kiln will be approximately 350 tons of quicklime per day.

Great Lakes Carbon Corp. planned to build a $20.5 million plant near Denning in Franklin County to manufacture carbon electrodes used in steelmaking. The plant was tentatively scheduled for operation in March 1979.

The U.S. Army Corps of Engineers held the groundbreaking for the Calion Lock and Dam on the Ouachita River-Black River Navigation System. The Calion project is the last of four projects on the System that will create a 330-mile-long, 9-foot-deep channel. The present navigation channel is 6.5 feet deep, and the increased depth will significantly increase freight haulage. About 1 million tons of commodities is now transported by barge annually, and it is anticipated that, when the project is completed in 1982, 3 to 3.5 million tons of materials will be moved annually. The contract for the Felsenthal Lock and Dam was let in August of 1977; this part of the navigation system works was scheduled for completion in 1981.

The State of Arkansas received about $82,000 from the Federal Government as the State's share of earnings from royalties paid on mineral producton from Federal lands in 1977. In all, the State was to receive nearly $3 million in Federal funds from timber fees and other fees paid for the use of Federal lands in the State.

The State Pollution Control and Ecology Department (PCE) has administered Arkansas' mined-land reclamation act that became effective July 1, 1971. The law was amended by the State legislature in 1977, changing certain regulations related to the permit system, payments of registration fees, and bounding requirements. In addition, all sand and gravel producers are now required to obtain permits. The State also opted to begin enforcement of new Federal laws on reclamation that pertain to coal mining operations. At yearend, the State was preparing plans for this endeavor. Under the State permit system, 201 permits have been issued since 1971 to 62 mining companies. From inception of the permit system to the end of fiscal year (FY) 1978, about 500 acres of mined land has been reclaimed satisfactorily, and reclamation was in progress on about 2,000 acres. Since 1971, permit fees for 5,171 acres have been collected; bond and escrow agreements total about $3,775,000. In FY 1978, 41 permits were issued covering 935 acres for mining various mineral commodities.

PCE issued 16 permits to the mineral industry to install air pollution control equipment at an estimated cost of $4.16 million in FY 1978. The department also issued eight permits to the mineral industry to install water pollution control equipment at an estimated cost of $2.9 million.

The Governor of Arkansas issued an executive order in 1977 that required all Arkansas counties and the cities therein to develop cooperative solid-waste management plans. The order was issued in compliance with the Federal Resource and Recovery Act of 1976. Counties may group together to form a solid-waste management plan that provides for disposal of sewage- and water-treatment sludge; industrial, agricultural, and mining wastes; and urban refuse. The counties must develop the plans in order to be eligible for solid-waste control funds available from the U.S. Environmental Protection Agency. The Federal law requires that all open dumps be eliminated by 1983.

North Little Rock began operation of its $1.5 million solid-waste incinerator plant in late 1977. The plant is equipped with a heat recovery system to generate 360,000 pounds of steam daily, which is then sold to industry. The incinerator system processes 100 tons per day of urban waste.

Federal funding in the amount of $6.3 million was made available to Blytheville Community College to construct an experimental solar energy system. The project will utilize photovoltaic cells to produce about 362 kilowatt-hours of electric power each 8-hour day. Mississippi County will provide $2.5 million to help fund the project. The project was scheduled to be operational in 1979.

Table 2.—Value of mineral production in Arkansas, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Ashley	$38	$194	Sand and gravel.
Baxter	W	948	Stone.
Benton	W	W	Stone, sand and gravel.
Boone	W	661	Do.
Bradley	W	286	Sand and gravel.
Calhoun	W	1,888	Do.
Carroll	W	W	Stone, sand and gravel.
Chicot	W	W	Sand and gravel.
Clark	W	W	Stone, sand and gravel.
Clay	165	42	Sand and gravel.
Cleburne	W	513	Stone, sand and gravel.
Columbia	97,905	W	Bromine.
Conway	W	W	Stone.
Craighead	1,324	1,282	Sand and gravel, clays.
Crawford	W	W	Sand and gravel, stone.
Crittenden	W	W	Clays, sand and gravel.
Cross	277	384	Sand and gravel.
Dallas	W	11	Do.
Desha	--	W	Do.
Drew	310	324	Do.
Faulkner	W	W	Stone, sand and gravel.
Franklin	W	W	Sand and gravel.
Fulton	W	W	Sand and gravel, stone.
Garland	W	W	Vanadium, abrasives, stone, sand and gravel.
Grant	632	415	Sand and gravel.
Greene	323	343	Do.
Hempstead	W	W	Sand and gravel, clays.
Hot Spring	1,917	W	Stone, sand and gravel, clays, barite, abrasives.
Howard	16,277	19,325	Cement, gypsum, stone, sand and gravel.
Independence	W	W	Stone, lime, sand and gravel.
Izard	7,065	6,875	Sand and gravel, stone.
Jackson	284	92	Sand and gravel.
Jefferson	95	W	Do.
Johnson	12,669	W	Sand and gravel, clays, stone.
Lafayette	W	862	Sand and gravel.
Lawrence	1,931	3,004	Stone, sand and gravel.
Lee	--	37	Sand and gravel.
Lincoln	172	544	Sand and gravel.
Little River	31,286	34,032	Cement, stone, sand and gravel, clays.
Logan	W	W	Sand and gravel, stone.
Lonoke	W	W	Stone, clays.
Madison	W	W	Stone, sand and gravel.
Marion	765	671	Sand and gravel, stone.
Miller	18,000	2,733	Sand and gravel.
Mississippi	1	16	Do.
Monroe	W	W	Do.
Montgomery	W	W	Barite, stone, sand and gravel.
Nevada	W	712	Sand and gravel.
Newton	6	W	Stone, sand and gravel.
Ouachita	W	1,852	Sand and gravel.
Perry	W	349	Stone.
Phillips	182	81	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Arkansas, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Pike	W	W	Sand and gravel, gypsum, abrasives.
Poinsett	$745	$537	Sand and gravel.
Polk	324	212	Do.
Pope	W	W	Sand and gravel, stone.
Pulaski	W	W	Stone, clays, sand and gravel, bauxite.
Randolph	W	18	Sand and gravel.
St. Francis	899	1,046	Do.
Saline	26,563	26,911	Bauxite, lime, sand and gravel, stone, soapstone, clays.
Searcy	W	W	Stone, sand and gravel.
Sebastian	21,266	W	Stone, sand and gravel, clays.
Sevier	397	366	Sand and gravel.
Sharp	318	38	Do.
Stone	W	W	Stone, sand and gravel.
Union	W	W	Bromine, sand and gravel.
Van Buren	W	W	Stone, sand and gravel.
Washington	W	W	Do.
White	W	W	Do.
Woodruff	W	W	Sand and gravel.
Yell	66	640	Do.
Undistributed[2]	[r]294,818	466,222	
Total[3]	[r]537,027	574,469	

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Arkansas, Cleveland, Prairie and Scott Counties were not listed because no production was reported.

[2] Includes value of petroleum, natural gas, natural gas liquids, and coal for 1977, gem stones, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Arkansas business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	873.0	915.0	+4.8
Unemployment	do	62.0	60.0	-3.2
Employment (nonagricultural):				
Mining	do	4.6	4.5	-2.2
Manufacturing	do	195.1	209.1	+7.2
Contract construction	do	34.5	37.1	+7.5
Transportation and public utilities	do	37.5	38.1	+1.6
Wholesale and retail trade	do	141.7	149.3	+5.4
Finance, insurance, real estate	do	27.9	29.2	+4.7
Services	do	93.4	97.3	+4.2
Government	do	125.3	128.1	+2.2
Total nonagricultural employment	do	660.0	692.7	+4.9
Personal income:				
Total	millions	$10,422	$11,878	+14.0
Per capita		$4,923	$5,540	+12.5
Construction activity:				
Number of private and public residential units authorized		8,818	11,294	+28.1
Value of nonresidential construction	millions	$110.4	$120.2	+8.9
Value of State road contract awards	do	$139.0	$170.0	+22.3
Shipments of portland and masonry cement to and within the State	thousand short tons	954	1,006	+5.4
Mineral production value:				
Total crude mineral value	millions	$537.0	$574.5	+7.0
Value per capita, resident population		$255	$268	+5.1
Value per square mile		$10,113	$10,818	+7.0

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

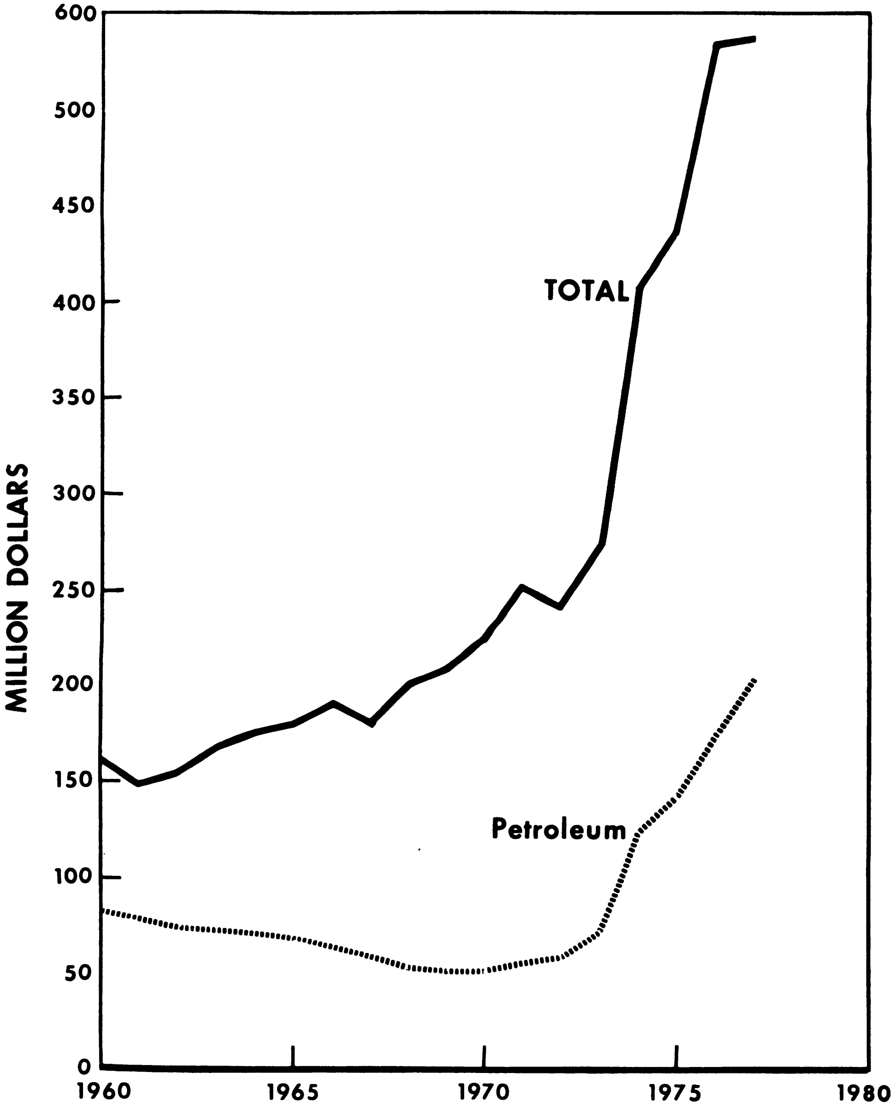

Figure 1.—Arkansas: Value of petroleum and total value of mineral production in Arkansas.

Arkansas residential construction contracts increased to $733.9 million in 1977, a 49.4% gain over 1976. Nonresidential construction contracts totaled $265.7 million, down 6.5% from comparable data of 1976. Personal income in Arkansas was placed at $11.9 billion, according to data supplied by the University of Arkansas, Bureau of Business and Economic Research.

Fertilizer use in Arkansas increased 10% to 787,358 tons during the crop year ending June 30, 1977, as announced by the Arkansas Crop and Livestock Reporting Service. Mixed fertilizer use increased by about 8%

to 431,400 tons, and direct application material totaled 356,000 tons, an increase of about 41,000 tons over that applied in 1976.

Employment.—The Employment Security Division, Arkansas Labor Department, reported that the mineral industry payroll totaled $66.4 million for 4,805 workers employed in mining activities in 1977. Total wages increased nearly 16% over comparable data for 1976. In 1977, workers in coal mining received an average of $396.70 per week; workers engaged in oil and gas extraction received an average of $267.19 per week; and, 2,121 metallic and industrial minerals workers received an average of $240.67 per week. The average weekly wage of all workers was $265.67. Mining continued to rank third in the State in terms of weekly wages paid to all classes of workers.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The total value for mineral fuels (petroleum, natural gas, bituminous coal, and natural gas liquids) was $288.1 million, about $32 million greater than that reported in 1976. Petroleum output at 20.2 million barrels was at its highest point since 1967 and continued its dominance in value over any other minerals produced in Arkansas. The second consecutive yearly increase was attributable to higher prices for oil. Natural gas output was valued at $60.9 million, establishing a new record high, but output was about 5.0 billion cubic feet lower than in 1976. Production of natural gas liquids was lower in 1977, but value increased substantially.

Lignite was prominent in the energy sector in 1977, as widespread exploration and development drilling was continued by three major companies. Carter Coal Co., a subsidiary of Exxon Corp.; Phillips Coal Co., a subsidiary of Phillips Petroleum Co.; and General Crude Oil Co., a subsidiary of International Paper Co. and Shell Oil Co. announced major reserves of lignite. Some deposits exceed 150 million tons. The potential use of lignite as a fuel for steam electric generation became increasingly apparent as substantial deposits sufficient to fuel electric generating facilities were delineated by drilling. Research studies related to liquefaction and gasification of lignite appeared to be encouraging. The Arkansas Geological Commission continued a major study designed to determine the extent, quality, and geological characteristics of lignite in the State. A preliminary report by the State agency indicated that lignite resources approach 13.5 billion tons in Arkansas. Arkansas lignite was expected to be used as fuel for electric power generation. The Arkansas Oil and Gas Commission issued its annual report for 1977, detailing information on oil and gas activities, production, and reserves.

NONMETALS

Abrasive Stone.—Eight mineral producers reported production of natural abrasive materials in 1977. Arkansas novaculite, used for whetstone or oilstone manufacture was mined in three counties and tripoli was produced in one county. Garland County accounted for most of the quantity and value of abrasive stone.

Barite.—Production of crude barite ore was again recorded in Montgomery County from the Dempsey Cogburn deposit by Baroid Division NL Industries, Inc. The ore was treated at the company flotation plant in Hot Spring County. Milchem, Inc. began exploration and evaluation of other barite deposits in the Fancy Hill District in Montgomery County. Preliminary information suggests that a new major barite operation in Arkansas may result. The Milwhite Co. continued production of ground barite at its plant in Saline County. All of the barite produced in the State was used in the manufacture of drilling muds.

Bromine.—Five companies produced elemental bromine in 1977. Total production was lower than the 1976 total and corresponding value decreased. Arkansas remained the leading State in domestic production not only in elemental bromine but in brominated compounds that found wide application. The pesticide dibromochloropropane was found to be a possible cause of sterility in plant workers where the compound was made. Two companies, Dow Chemical and Velsicol, were involved in the compounding of the chemical either in Arkansas or at out-of-State locations. Chemical companies in other States also produced the pesticide. Arkansas producers stopped production of the pesticide and acted to limit use of the compound. The chemical had been widely used since 1955 as an agent to kill roundworm nematodes in plant root systems.

Legislation proposed by a Governor-appointed brine study committee was referred to a joint House-Senate interim committee for further study. The legislation would change royalty rates that determine the amount of money paid landowners by bromine producers, and would bring brine-producing companies under jurisdiction of the Arkansas Oil and Gas Commission. Further action by the Arkansas Legislature was postponed indefinitely.

More than half the bromine output was utilized in compounding ethylene dibromide used in making leaded gasoline. Ethyl bromide, methyl bromide, and hydrobromic acid were also produced in significant quantities by Arkansas' bromine industry. Over one-half of the world's supply of bromine was produced in Arkansas.

Cement.—Larger volumes of both portland and masonry cements were marketed in 1977 than in 1976, and attendant values increased more than 10% compared with combined value reported in 1976. Ideal Basic Industries, Inc. and Arkansas Cement Corp. used limestone (chalk), clay, sand, gypsum, and iron oxides in making cement. The major fuel used continued to be natural gas, but both plants have facilities to burn coal to fire the cement kilns. Ready-mix concrete companies, building contractors, concrete products users, and highway construction provided major markets for the cement.

Clays.—Clays of various classifications were produced in 10 counties. Eleven companies were involved in clay mining and clay products manufacturing. Total clay output, including kaolin, declined about 6%, but combined value of clays increased 59% in 1977. Hot Spring, Crittenden, Lonoke, and Pulaski Counties accounted for the major share of clay output in the State. More than half of the clay produced was used in facebrick manufacturing; other uses included refractory brick, high aluminum refractory products, lightweight aggregates, and cement manufacture.

Gem Stones.—More than 90,000 people visited Arkansas Crater of Diamonds State Park, where at least 370 diamonds were reportedly found according to State Parks and Tourism officials. Most of the diamonds found were well under one carat in weight, but some were as large as one-to-four-carats and were of excellent quality. The largest diamond found in recent years was a 16-carat, 37-point, clear-white stone found in 1975.

Wavellite, jasper, and quartz crystals were produced and sold as mineral specimens, and amateurs and prospectors reported finds of these minerals and rocks as well as gypsum and zinc. More that 500,000 pounds of quartz crystal was mined and used in synthesizing quartz used in electronic applications.

Gypsum.—Two companies accounted for all of Arkansas' gypsum output, which again increased significantly in 1977. Value increased more than 70% above that of 1976. Market improvements in building, construction, and cement manufacture accounted for the increase. Much of the gypsum used in cement manufacture was supplied by Arkansas Gypsum Co. in Pike County. Weyerhaeuser Co. continued operation of its mine and gypsum wallboard plant in Howard County. Temple Gypsum Inc., using crude gypsum mined in Oklahoma, manufactured wallboard at its West Memphis plant.

Lime.—Rangaire Corp. in Independence County announced plans to expand lime production and to convert from natural gas to coal as a fuel source. The company produced quicklime and hydrated lime near Batesville for the paper and pulp industries and for soil stablization, water purification, and other uses. Aluminum Company of America (Alcoa) and Reynolds Metals Co. produced quicklime at their alumina plants in Saline County. Both companies used limestone that was mined in Izard County. Total lime output in the State decreased about 16.5%, and value declined 7% from comparable data reported in 1976. Arkansas industries provided major markets but substantial shipments were made to Louisiana, Tennessee and other States.

Sand and Gravel.—Production of sand and gravel was about 1.4 million tons greater in 1977 than in 1976. Value was just over $36.0 million. Sand and gravel output was reported from 67 counties. The five leading counties, ranked in order of production were Pulaski, Crawford, Miller, Calhoun, and Ouachita. Craighead and Calhoun Counties led in number of operating sand and gravel mines. Sand and gravel ranked sixth in the State in terms of mineral value. Eleven Arkansas counties reported outputs in excess of 500,000 tons each, signifying the diverse geologic environments and wide geographic distribution. Most of the output was used in concrete aggregate for all types of building and construction. Arkansas State Highway and Transportation Department provides the largest single market in the State. Asphaltic concrete production and sand and gravel used in roadbase construction and as coverings accounted for about 6.9 million tons of output. Fill and concrete products were also important markets.

Silica sand was produced in Izard County for the 57th consecutive year by Silica Products Co. Most of the industrial sand output in the State came from this operation.

Table 4.—Arkansas: Sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	5,917	$10,416	$1.76
Gravel	9,650	19,481	2.02
Total or average	15,567	29,897	1.92
Industrial:			
Sand	W	W	W
Gravel	W	W	W
Total or average	543	6,194	11.41
Grand total or average	16,110	36,091	2.24

W Withheld to avoid disclosing company proprietary data.

Table 5.—Arkansas: Sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	6,526	$13,977	$2.14
Concrete products	651	1,462	2.24
Asphaltic concrete	2,287	5,068	2.22
Roadbase and coverings	4,627	7,614	1.65
Fill	1,174	1,331	1.13
Other uses	301	445	1.48
Total or average	15,567	29,897	1.92

Soapstone (Talc).—The Milwhite Co., Inc. produced soapstone in Saline County for the 27th consecutive year. Output of ground soapstone sold for use as dusting agents for roofing and rubber goods was lower than that reported in 1976.

Stone.—Stone output consisted of chalk, limestone, dolomite, nepheline syenite (classified as granite), slate, novaculite, sandstone, and dimension stone. The output and value of dimension sandstone decreased sharply. Fair Stone Co., Inc., Logan County Building Stone Co., Sunset Stone Co., and Orin McBride Masonry Stone Co. quarried sandstone that provided sawed (cut) building stone, rough dimension sandstone, and broken stone for other uses. Output was 13,350 tons valued at $360,000.

Crushed stone production from 34 counties in the State represented a host of stone types. Thirty-six companies operated 71 quarries for roadbase aggregate, concrete aggregate and roadstone, cement manufacture, roofing granules, and other uses. Output increased about 3% to 18.3 million tons valued at $45.4 million. Leading producers included McGeorge Contracting Co., Ashland Oil Inc. (Arkhola Sand & Gravel Co.), and Minnesota Mining & Manufacturing Co.

Arkansas ranked second in the country in crushed sandstone output, third in crushed slate, and fifth in production of crushed granite (nepheline syenite). The five leading counties were Pulaski (nepheline syenite), Little River (chalk), Lawrence (limestone), Independence (limestone), and Washington (limestone). Stone output in Pulaski County far outranked all other counties in the State.

The State's sandstone was produced principally in Crawford, Sebastian, Clark, Faulkner, and Lonoke Counties. This stone was used in virtually all markets except as a cement raw material.

Nepheline syenite (classified as granite) was produced only in Pulaski County. In addition to its principal use as aggregate, much of the stone was used in making roofing granules.

Limestone was produced in 13 counties. Chalk was mined in Little River and Howard Counties for cement manufacture.

Slate was mined in Montgomery and Saline Counties, novaculite in Garland and Hot Spring Counties, and dolomite in Baxter County.

Table 6. Arkansas: Crushed stone sold or used, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	3,414	6,876	4,076	8,623
Roadstone	3,033	6,186	2,808	6,574
Cement manufacture	1,812	2,318	W	W
Bituminous aggregate	1,731	7,721	1,786	8,464
Riprap and jetty stone	1,166	2,293	1,530	3,242
Roofing granules	1,300	2,904	1,463	3,947
Concrete aggregate	1,663	3,318	1,096	2,490
Railroad ballast	1,159	2,261	988	2,223
Agricultural limestone	544	1,379	568	1,618
Surface treatment aggregate	328	822	325	974
Filter stone	W	W	44	116
Other uses[2]	1,550	3,636	3,627	7,175
Total[3]	17,701	39,713	18,310	45,448

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, syenite, sandstone, slate, and miscellaneous stone.

[2] Includes stone used for flux stone, fill, lime manufacture, asphalt filler, mineral food, soil conditioning, slate flour, paper manufacture, glass manufacture, refractory stone, abrasives, other filler, ferrosilicon (1976), other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Sulfur (Recovered Elemental).—The Ethyl Corp. and Phillips Petroleum Co. were the only companies to report recovery of sulfur in south Arkansas. Ethyl Corp., through operation of its sulfur recovery unit, stripped sulfur from bromine-bearing brines in Columbia County largely in an effort to control pollution. Phillips Petroleum Co. treated sour natural gas at its gas-cleaning plant in the McKamie-Patton Field in Union County. Total production of recovered sulfur in Arkansas increased in 1977, but value of the output declined.

Vermiculite.—W.R. Grace & Co. in Pulaski County and Strong-Lite Products in Jefferson County continued production of exfoliated vermiculite from raw materials shipped into the State. The products were used as concrete and plaster aggregate, loose fill and block insulation, for horticulture purposes and soil conditioning, premixes, and other applications. Strong-Lite products also processed perlite, a volcanic glass, to manufacture material used in horticulture and cryogenic applicatons.

METALS

Bauxite, the principal domestic source of aluminum, and vanadiferous clays comprised the chief metallic commodities produced in the State. A substantial quantity of gallium metal was extracted in connection with bauxite conversion to alumina at one plant. Exploration for zinc and lead continued in north Arkansas and uranium potentials were studied in south Arkansas.

Aluminum.—Production of aluminum increased in Arkansas in 1977, as Reynolds Metals Co. operated company aluminum reduction plants at Jones Mills in Hot Spring County and Gum Springs in Clark County on a rated-capacity basis. Reynolds also continued operation of its wire and cable plant at Jones Mills and announced plans to expand the plant facilities. As part of the expansion project, the company will manufacture steel-supported aluminum conductors. The company also announced plans to construct a new $39 million continuous casting and cold-rolling mill to produce sheet aluminum that will be processed to foil wrap at other Reynolds operations. Molten aluminum from the Jones Mills reduction plant will furnish the feedstock for the casting and rolling mill. About 140 million pounds of foil stock will be produced annually. The plant is scheduled for operation in 1980. The continuous casting process will permit an energy savings of about 32% annually.

The Aluminum Company of America (Alcoa) and Reynolds Metals Co. continued production of alumina at their plants in Saline County. Outputs at both plants were near capacity. Plant products included alumina chemicals and alumina feedstock for metal reduction operations.

Bauxite.—Arkansas again led the three States in the Nation that produced bauxite with about 84.6% of the total production. Reynolds Mining Co., Alcoa, and American Cyanamid Co. reported bauxite production in 1977. Processing plants producing alumina, alumina chemicals, and activated and calcined bauxite were operated by Alcoa, Reynolds Metals, American Cyanamid, Porocel Corp., and Stauffer Chemical Co. Reynolds Metals continued to import bauxite from foreign sources to blend with domestic ore. The companies mining bauxite continued mined-land reclamation projects and operation of waste-water treatment plants.

Table 7.—Arkansas: Mine production of bauxite and shipments from mines and processing plants to consumers in the United States

(Thousand long tons and thousand dollars)

Year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dry equivalent	Value[1]	As shipped	Dry equivalent	Value[1]
1973	2,040	1,686	23,884	2,076	1,780	26,708
1974	2,098	1,731	23,597	2,130	1,810	26,737
1975	1,862	1,543	22,956	1,883	1,599	[r]25,412
1976	2,013	1,667	24,481	2,035	1,728	27,580
1977	2,016	1,676	24,851	1,933	1,657	26,532

[r] Revised.

[1] Computed from selling prices and values assigned by producers and from estimates by the Bureau of Mines.

Vanadium.—Production of vanadiferous clays and related materials was continued by Union Carbide Corp. at its vanadium oxide mine/mill complex in Garland County. The level of production decreased significantly because of the decline in demand for the company product, a ferrovanadium alloy used in steelmaking. Although output diminished, the Arkansas operation continued to lead in the United States as the principal source of vanadium oxide. The company announced in November that the operation would cease for an indefinite period. It was expected that mine and mill operations would stop at the end of the first quarter of 1978, but operations were anticipated to resume in the latter part of 1978 or early 1979.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
Malvern Minerals Co	Box 1246 Hot Springs AR 71901	Mine	Garland.
Norton-Pike Co.	Littleton, NH 03561	do	Do.
Barite:			
NL Industries, Inc	Box 1675 Houston, TX 77001	do	Hot Spring.
Bauxite:			
Aluminum Company of America[1]	1501 Alcoa Bldg. Pittsburgh, PA 15219	do	Saline.

See footnotes at end of table.

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[1] State Liaison Officer, Bureau of Mines, Little Rock, Ark.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Bauxite —Continued			
American Cyanamid Co	Berdan Ave. Wayne, NJ 07470	Mine and plant	Saline.
Reynolds Metals Co.[2]	Box 398 Bauxite, AR 72011	do	Do.
Bromine:			
Arkansas Chemicals, Inc	Route 6, Box 98 El Dorado, AR 71730	Brine wells and plant	Union.
The Dow Chemical Co.	Midland, MI 48640	do	Columbia.
Ethyl Corp.[3]	451 Florida St. Baton Rouge, LA 70801	do	Do.
Great Lakes Chemical Corp	Box 2200 West Lafayette, IN 47901	do	Union.
Velsicol Chemical Corp	352 East Ohio St. Chicago, IL 60611	do	Do.
Carbon black:			
Cities Service Co	3200 West Market St. Akron, OH 44313	Furnace	Do.
Cement:			
Arkansas Cement Corp.[4]	Foreman, AR 71836	Pit and plant	Little River.
Ideal Basic Industries, Inc.[4]	420 Ideal Cement Bldg. Denver, CO 80202	do	Howard.
Clays:			
Acme Brick Co	Box 425 Fort Worth TX 76101	do	Hot Spring and Sebastian.
Arkansas Lightweight Aggregate Corp.	El Dorado, AR 71730	do	Crittenden and Lonoke.
W. S. Dickey Clay Manufacturing Co.	Texarkana, AR 75501	do	Miller.
Coal:			
Crown Construction Co., Inc	Fort Smith, AR 72902	Strip mine	Johnson.
Garland Coal & Mining Co	Fort Smith, AR 72901	do	Franklin.
Peobody Coal Co	St. Louis, MO 63102	do	Johnson.
Sugarloaf Mining Co	Fort Smith, AR 72901	Strip and underground mine.	Sebastian.
Gypsum:			
Weyerhaeuser Co	Route 4, Box 78 Nashville, AR 71852	Mine and plant	Howard.
Lime:			
Rangaire Corp.[5]	Box 1311 Batesville, AR 72501	Plant	Independence.
Natural gas liquids:			
Arkla Chemical Corp.[3]	Magnolia, AR 71753	do	Columbia.
Phillips Petroleum Co.[3]	Stamps, AR 71860	do	Lafayette.
Petroleum refineries:			
Berry Petroleum Co	Magnolia, AR 71753	Refinery	Ouachita.
Cross Oil & Refining Co. of Arkansas.	Smackover, AR 71762	do	Union.
Lion Oil Co.[3]	El Dorado, AR 71730	do	Do.
Roofing granules:			
Bird & Son, Inc	East Walpole, MA 02032	Plant	Montgomery.
Minnesota Mining & Manufacturing Co.[5]	Little Rock, AR 72203	do	Pulaski.
Sand and gravel:			
Arkhola Sand & Gravel Co	323 Merchants Bank Fort Smith, AR 72901	Pit	Crawford.
Gifford-Hill & Co., Inc.	Box 47127 Dallas, TX 75247	Pit	Lafayette and Miller.
Jeffrey Sand Co., Inc	Fort Smith, AR 72901	Dredge	Pulaski.
Stone:			
Arkhola Sand & Gravel Co	323 Merchants Bank Fort Smith, AR 72901	Pit	Crawford.
Freshour Construction Co	Box 77 Sweet Home, AR 72164	Quarries	Sharp, Van Buren, White.
Ben M. Hogan Co., Inc	Box 2860 Little Rock, AR 72203	do	Lawrence and Pope.
McClinton Brothers Co	Box 1367 Fayetteville, AR 72701	do	Benton, Madison, Washington.
McGeorge Contracting Co	Box 248 Pine Bluff, AR 71601	Quarry	Pulaski.
Midwest Lime Co	Box 608 Batesville, AR 72501	do	Independence.
Minnesota Mining & Manufacturing Co.	Little Rock, AR 72203	do	Do.
Talc and soapstone:			
The Milwhite Co., Inc.[5]	Box 15038 Houston, TX 77020	Mine and plant	Saline.
Vanadium:			
Union Carbide Corp	Route 2, Box 563 Hot Springs, AR 71901	Mine and mill	Garland.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Vermiculite (exfoliated):			
Strong-Lite Products	Pine Bluff, AR 71601	Plant	Jefferson.

[1] Also lime and cement.
[2] Also lime.
[3] Also recovered sulfur.
[4] Also clays and stone.
[5] Also stone.

The Mineral Industry of California

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the California Department of Conservation, Division of Mines and Geology, for the collection of mineral data.

By John R. McWilliams[1]

The total value of all mineral production in California in 1977 increased $828 million to $4.3 billion, an advance of 24% compared with that of 1976. Much of the increase was due to the inflationary trend in mineral commodity prices during 1977. Production of a number of commodities including asbestos, copper, gold, gypsum, iron ore, lime, pumice, carbon dioxide, feldspar, phosphate rock, potassium salts, salt, sodium sulfate, and natural gas declined in 1977.

Crude petroleum again was the most valuable mineral commodity accounting for 59% of the total value of all mineral output. When natural gas and natural gas liquids are included, the value of hydrocarbons increases to 69% of the State's total output. Production of crude petroleum increased 24 million barrels (7%) while its value increased $550 million (27%). Natural gas production declined 42,872 million cubic feet (MMCF) (12%) but its value increased $31 million (9%).

Output of other major mineral commodities such as portland cement, clays, sand and gravel, boron, stone, talc, and diatomite all increased. Portland cement, the most important mineral commodity after the hydrocarbons, accounted for $406 million or 9% of the total value of mineral production in the State, an increase of $113 million over that of 1976. Production of portland cement increased 17% to 9 million tons as the result of a continued high level of construction activity. Sand and gravel, the third most important mineral product in the State in terms of value, also benefited from construction activity. Production of sand and gravel increased 13 million tons or 13% in 1977 to exceed 109 million tons. Value of sand and gravel increased 24% or $49 million and accounted for 6% of the total value of the State's mineral production. Boron minerals accounted for $236 million or 6% of the State's total production, an increase of 28% over that of 1976. Petroleum, natural gas, natural gas liquids, portland cement, sand and gravel, and boron accounted for 90% of the State's mineral production valued at $3.9 billion. Other important mineral commodities in terms of value of output included stone, iron ore, diatomite, tungsten, magnesium compounds, lime, sodium sulfate, asbestos, salt, rare earths, clays, potassium salts, and sodium carbonate. These commodities accounted for nearly all of the remaining 10% of the total mineral value.

Ninety-seven percent of the mineral production value is in nonmetallic minerals including hydrocarbons, saline salts, and gem stones. The principal metallic minerals in addition to iron ore and tungsten, are rare earths, molybdenum, gold, copper, and silver. Metals accounted for 3% of the total production, valued at $136 million. In all, a total of 39 mineral commodities were produced in California during 1977.

Table 1.—Mineral production in California[1]

Mineral	1976		1977[p]	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Asbestos short tons	78,390	$15,706	76,247	$18,372
Boron minerals thousand short tons	1,246	184,852	1,469	236,163
Cement:				
Masonry do.	1	48	W	W
Portland do.	7,896	293,645	9,271	406,185
Clays do.	2,296	13,570	2,655	12,179
Copper (recoverable content of ores, etc.) short tons	375	522	221	295
Diatomite thousand short tons	386	37,372	397	43,405
Gem stones	NA	231	NA	230
Gold (recoverable content of ores, etc.) troy ounces	10,392	1,302	5,704	846
Gypsum thousand short tons	1,647	7,897	1,629	8,500
Iron ore (usable) thousand long tons, gross weight	3,042	W	W	W
Lead (recoverable content of ores, etc.) short tons	54	25	3	2
Lime thousand short tons	638	23,324	598	24,074
Mercury 76-pound flasks	296	36	W	W
Natural gas million cubic feet	354,334	333,074	311,462	364,099
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels	4,626	31,655	8,117	61,873
LP gases do.	4,151	25,487		
Petroleum (crude) do.	326,021	2,005,577	349,609	2,555,965
Pumice thousand short tons	705	3,245	636	3,838
Sand and gravel do.	96,592	202,272	109,135	250,951
Silver (recoverable content of ores, etc.) thousand troy ounces	57	249	58	267
Stone thousand short tons	32,377	75,352	34,037	81,142
Talc short tons	56,871	1,513	95,602	2,373
Zinc (recoverable content of ores, etc.) do.	170	126	2	1
Combined value of calcium chloride, carbon dioxide, feldspar, lithium compounds, magnesium compounds, molybdenum, peat, perlite, phosphate rock, potassium salts, rare-earth concentrates, salt, sodium carbonate, sodium sulfate, tungsten, and items indicated by symbol W	XX	226,293	XX	241,064
Total	XX	3,483,373	XX	4,311,824
Total 1967 constant dollars	XX	1,788,015	XX	[p]2,128,316

[p] Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in California, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Alameda	W	W	Sand and gravel, salt, stone, clays.
Alpine	$107	$239	Silver, gold, sand and gravel, zinc, lead, copper.
Amador	W	W	Sand and gravel, stone, clays.
Butte	2,638	W	Sand and gravel, silver, gold.
Calaveras	32,635	38,256	Cement, asbestos, stone, sand and gravel, clays.
Colusa	W	W	Sand and gravel.
Contra Costa	8,511	W	Stone, sand and gravel, lime, clays.
Del Norte	1,277	920	Sand and gravel, stone.
El Dorado	W	W	Stone, sand and gravel, talc.
Fresno	76,894	9,076	Sand and gravel, asbestos, stone, gold, tungsten, clays, silver.
Glenn	W	W	Sand and gravel, lime, stone.
Humboldt	2,484	2,066	Sand and gravel, stone.
Imperial	W	W	Gypsum, sand and gravel, lime, salt.

See footnotes at end of table.

Table 2.—Value of mineral production in California, by county[1] [2]—Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Inyo	$33,152	$46,430	Tungsten, boron minerals, talc, molybdenum, perlite, stone, sand and gravel, pumice, copper, silver, clays, gold, lead.
Kern	1,086,799	147,715	Cement, boron minerals, stone, sand and gravel, gypsum, clays, tungsten, carbon dioxide, salt, pumice.
Kings	W	--	
Lake	W	W	Pumice, sand and gravel, stone.
Lassen	167	606	Sand and gravel, stone, pumice.
Los Angeles	593,245	W	Sand and gravel, stone, lime, clays, tungsten.
Madera	1,137	W	Pumice, stone.
Marin	W	W	Stone, clays, sand and gravel.
Mariposa	W	W	Sand and gravel, stone.
Mendocino	998	1,233	Do.
Merced	1,932	1,186	Do.
Modoc	W	W	Stone, peat, pumice, sand and gravel.
Mono	1,604	1,624	Pumice, clays, gold, sand and gravel, silver, lead, copper.
Monterey	114,629	W	Magnesium compounds, lime, stone, sand and gravel.
Napa	2,790	W	Stone, salt, mercury, sand and gravel.
Nevada	W	W	Sand and gravel, stone, clays.
Orange	207,188	W	Sand and gravel, feldspar, clays, lime, stone.
Placer	W	W	Sand and gravel, clays, stone.
Plumas	1,486	W	Stone, sand and gravel, gold, pumice, silver.
Riverside	122,692	W	Iron ore, cement, sand and gravel, stone, clays.
Sacramento	W	W	Sand and gravel, stone, gold, silver.
San Benito	10,943	W	Asbestos, stone, sand and gravel, clays.
San Bernardino	274,214	455,012	Boron minerals, cement, sodium sulfate, rare-earth minerals, stone, sodium carbonate, potash, sand and gravel, lime, clays, salt, calcium chloride, talc, pumice, lithium minerals, feldspar, iron ore, tungsten, gypsum.
San Diego	29,086	37,439	Sand and gravel, stone, magnesium compounds, clays, gypsum.
San Joaquin	7,696	W	Sand and gravel, lime, peat, gold, silver.
San Luis Obispo	W	W	Sand and gravel, stone, clays.
San Mateo	10,791	W	Magnesum compounds, stone, salt, sand and gravel.
Santa Barbara	153,254	W	Diatomite, sand and gravel, lime, phosphate rock, stone.
Santa Clara	W	W	Cement, stone, sand and gravel.
Santa Cruz	W	W	Cement, sand and gravel, stone, clays.
Shasta	12,758	17,954	Cement, sand and gravel, stone, clays, pumice.
Sierra	608	W	Gold, silver, stone.
Siskiyou	1,886	2,172	Sand and gravel, pumice, stone.
Solano	1,655	7,546	Sand and gravel, stone.
Sonoma	W	W	Stone.
Stanislaus	W	W	Sand and gravel, gold, clays, silver.
Sutter	W	W	Sand and gravel, clays.
Tehama	W	491	Sand and gravel, stone, pumice.
Trinity	W	W	Stone, sand and gravel, gold.
Tulare	2,805	W	Sand and gravel, stone, tungsten.
Tuolumne	W	W	Lime, stone, gold.
Ventura	156,793	W	Sand and gravel, clays, stone, pumice.
Yolo	W	W	Sand and gravel, lime, stone.
Yuba	W	W	Sand and gravel, stone, clays.
Undistributed[3]	528,516	3,541,861	
Total[4]	3,483,373	4,311,824	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] No production was reported for San Francisco County.

[2] Value of petroleum is based on an average price per barrel for the State.

[3] Includes natural gas, natural gas liquids, petroleum, and mercury that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of California business activity

	1976	1977^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force .... thousands..	9,701.0	10,140.0	+4.5
Unemployment .... do....	888.0	834.0	-6.1
Employment (nonagricultural):			
Mining .... do....	34.7	35.0	+.9
Manufacturing .... do....	1,650.9	1,709.9	+3.6
Contract construction .... do....	317.6	360.7	+13.6
Transportation and public utilities .... do....	463.9	474.4	+2.3
Wholesale and retail trade .... do....	1,875.6	1,969.8	+5.0
Finance, insurance, real estate .... do....	468.7	499.3	+6.5
Services .... do....	1,649.0	1,738.3	+5.4
Government .... do....	1,692.3	1,734.7	+2.5
Total nonagricultural employment .... do....	8,152.7	8,522.1	+4.5
Personal income:			
Total .... millions..	$155,374	$173,214	+11.5
Per capita	$7,219	$7,911	+9.6
Construction activity:			
Number of private and public residential units authorized	220,134	270,971	+23.1
Value of nonresidential construction .... millions..	$2,736.0	$3,801.5	+38.9
Value of State road contract awards .... do....	$186.9	$430.0	+130.1
Shipments of portland and masonry cement to and within the State .... thousand short tons..	7,303	8,537	+16.9
Mineral production value:			
Total crude mineral value .... millions..	$3,483.4	$4,311.8	+23.8
Value per capita, resident population	$162	$197	+21.6
Value per square mile	$21,950	$27,171	+23.8

^p Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

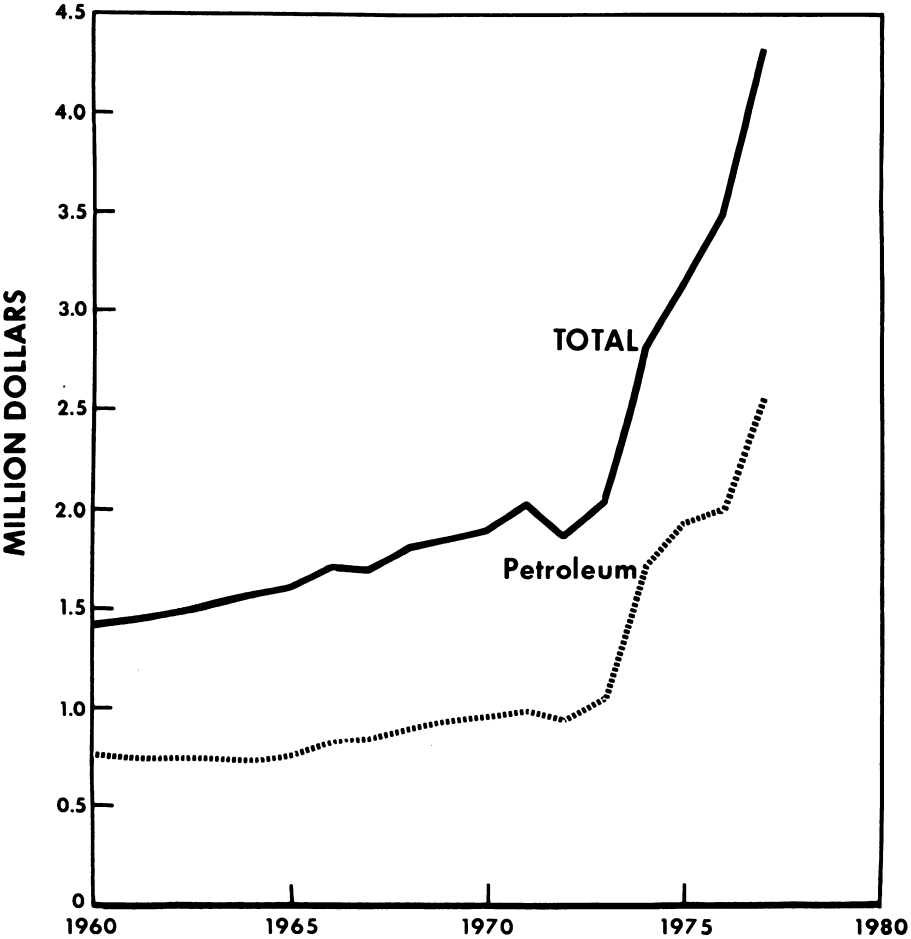

Figure 1.—Value of petroleum and total value of mineral production in California.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Geothermal.—In 1977, 14 geothermal prospect wells were drilled, a 30% decrease from 1976; 21 development wells were drilled, a 16% increase; and 60 observation wells were drilled. Development drilling at The Geysers totaled 21 wells in 1977, 3 more than in 1976. Power generation remained at 502 megawatts. The price for steam increased 25% from 11.35 mills per kilowatt-hour in 1976 to 14.18 mills per kilowatt-hour in 1977.

A geothermal task force created in 1976 with representation from the legislation, the public, and State agencies recommended that geothermal development be encouraged consistent with environmental standards. Local jurisdictions are encouraged to designate areas for geothermal development and retain land use authority for geothermal wells, steam lines, and related facilities.

The Federal Government claims ownership of geothermal resources under private lands at The Geysers and elsewhere where the lands were acquired under the Homestead Act of 1916.

Preproduction topographic surveys were undertaken in three areas of the Imperial Valley to establish bench-line references to monitor possible subsidence after production begins. Additional geothermal resources are known at Coso Hot Springs, near China Lake, Inyo County; in Mono County, where a ski resort will test the feasibility of using geothermal energy for heating and snow removal; and in Lassen County where low-temperature geothermal water will be used to heat greenhouses for the production of vegetables.

Natural Gas.—Production of natural gas declined 12% or 43 billion cubic feet in 1977, while value increased 9% or $31 million.

California's net natural gas production declined for the ninth year in a row. Production totaled 311 billion cubic feet in 1977, a decrease of 12% from that of 1976. California ranked sixth in the Nation among gas-producing States. Recoverable gas reserves were estimated at 4.6 trillion cubic feet.

Natural Gas Liquids.—Natural gas liquids (natural gasoline and cycle products and liquefied petroleum gases) declined 8% to 8,117 thousand barrels but value increased 8% to $61,873,000.

Petroleum.—Crude petroleum production in California increased from 326 million barrels in 1976 to 350 million barrels in 1977, an increase of 24 million barrels or 7%. The value of production increased from $2.0 billion to $2.6 billion in 1977, an increase of 27%. The most productive sources were the Wilmington field in Los Angeles County, with a daily average output of 144,000 barrels, and the Elk Hills, Midway-Sunset, and Kern River fields, all in Kern County, with an average combined daily production of 309,000 barrels. The last three fields have been in operation 50 years or more. The Elk Hills field was reopened to help offset imports of crude oil.

Crude petroleum statistics and summaries of oil operations are published annually by the California Division of Oil and Gas and by the Conservation Committee of California Oil Producers.[2] [3]

California's oil was produced from 234 active fields at a rate of about 924,000 barrels per day. There were 43,361 active oil wells in operation at the end of 1977, an increase of about 830 over 1976. Enhanced recovery projects accounted for about 50% of the State's production. Steam stimulation accounted for 27% of the State's total, and water flooding accounted for 19%. Estimated recoverable oil reserves as of December 31, 1977, totaled 4.4 billion barrels. The number of exploratory wells drilled increased from 233 in 1976 to 235 in 1977. During the year, 8 new fields were discovered (7 gasfields and 1 oilfield), 19 new pools were discovered (6 in gasfields and 13 in oilfields), and the productive areas of 16 fields were extended (6 in gasfields and 10 in oilfields). At yearend, most California fields were operating at or near capacity.

NONMETALS

Asbestos.—Production of asbestos decreased 3% but value increased 17% in 1977. More than two-thirds of the Nation's production came from California. The major producer within the State was the Calaveras Asbestos Corp. operations at Copperopolis, Calaveras County. Other producers included Union Carbide Corp., which operated the Santa Rita mine in San Benito County, and the Atlas Asbestos Corp., which operated the Santa Cruz mine in Fresno County.

Barite.—No barite was mined in California during 1977. Production from two plants producing ground and crushed barite from out-of-State crude barite declined 10%. Most of the ground and crushed barite was sold for use in well drilling. The remainder was used in producing barium chemicals.

Boron.—All of the boron produced in the United States was supplied by operations in California, largely from Kern County but with some production from San Bernardino and Inyo Counties. Production increased 18% and value of output increased 28% reflecting increased demand during the year. Borate materials were used in the manufacture of fire-resistant cellulose insulation.

U.S. Borax and Chemical Corp., which operates an open pit mine and a processing plant at Boron, Kern County, continued to be the world's largest source of boron. The $54 million expansion program to increase production of its principal products, pentahydrate and decahydrate, by 30% to 35% was completed in 1977. The program involved extensive changes to improve ore mining and handling and increase the capacity of the processing facilities.

American Borate Corp., which purchased Tenneco Oil Co.'s boron mining and processing operations in California and Nevada, continued to mine colemanite and ulexite from an open pit in Death Valley National Monument near the old mining town of Ryan, Inyo County. Owens-Corning Fiberglas Corp. and Texas United Corp. have formed a partnership to develop an underground mine in the same area.

Kerr-McGee Chemicals Corp. produced anhydrous borax and boric acid as well as pentahydrate and decahydrate at its plants in San Bernardino County.

Calcium Chloride.—Leslie Salt Co. and National Chloride Co. of America continued to produce calcium chloride from wells in San Bernardino County. The Leslie Salt operation is at Amboy and the National Chloride plant is at Bristol Lake.

Cement.—Shipments of portland cement increased 17% while value increased 38% compared with that of 1976 due to increased demand. Of the total sales, 71% was used by ready-mix concrete companies, 9% by building material dealers, 13% by concrete products manufacturers, 2% by highway contractors, 3% by other contractors, and the remainder by Government and miscellaneous customers. Of the total shipments of finished portland cement, 89% was moved in bulk while 11% was transported in containers.

Natural gas was the predominant fuel for firing the cement kilns but because of the cost and possible curtailment or interruption of service, many of the companies converted to other fuels, usually coal, but one company in northern California used a mixture of coal and wood chips. The wood chips are a product of the local lumbering industry and formerly were regarded as a waste disposal problem. Raw materials consumed in manufacturing cement included 12.4 million tons of limestone and other calcareous materials, 916,000 tons of argillaceous materials (mainly clay and shale), 242,000 tons of siliceous material, 154 tons of ferriferous material, and 1 million tons of clinker, gypsum, and other material.

A total of 12 portland cement plants were in operation during 1977, the same number and distribution as in 1976, 4 in northern California and 8 in southern California. Only one masonry cement plant was active in the State during 1977.

Table 4.—Southern California: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	8	8
Production	5,514,593	6,499,322
Shipments from mills:		
Quantity	5,539,402	6,496,202
Value	$201,629,622	$284,525,905
Stocks at mills, Dec. 31	224,255	238,077

Table 5.—Northern California: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	4	4
Production	2,376,896	2,541,331
Shipments from mills:		
Quantity	2,356,529	2,774,341
Value	$92,015,764	$121,658,964
Stocks at mills, Dec. 31	151,987	107,395

Table 6.—California: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	12	12
Production	7,891,489	9,040,653
Shipments from mills:		
Quantity	7,895,931	9,270,543
Value	$293,645,386	$406,184,869
Stock at mills, Dec. 31	376,242	345,472

Clays.—Clay was produced in 24 counties by 43 companies at 68 mines in 1977. Total output was 16% greater than in 1976 but value declined 10%. Unit value was $4.73 per ton overall compared with $5.91 per ton in 1976 and $9.48 per ton in 1975. Of the total quantity of clays sold or used, common clay accounted for 94% of the tonnage and 67% of the value, bentonite accounted for 3.7% of the tonnage and 22% of the value, and kaolin accounted for 2.6% of the tonnage and 4.4% of the value. Ball clay accounted for less than 1% of the value and quantity.

The average value of common clay was $3.37 per short ton, bentonite was $28.23 per short ton, and kaolin was $7.88 per short ton. Major uses of clay were in the manufacture of cement, common brick, face brick, sewer pipe, roof tile, pottery, and as lightweight aggregate in concrete block, structural concrete, and other products.

Diatomite.—As in 1976, four mining companies in Santa Barbara County produced all of the diatomite mined in the State. They were Johns-Manville Sales Corp., and Grefco, Inc., both at Lompoc; Airox Earth Resources, Inc., at Santa Maria; and Excel-Minerals Co., at Taft. Production increased 3% and value increased 16% in 1977. Most of the production was used in filtration and as filler with the remainder used for insulation, lightweight aggregate, and miscellaneous uses. Nearly two-thirds of the Nation's production of diatomite in 1977 came from California.

Feldspar.—Feldspar production was reported from two mines, the Mission Viejo mine of Owens-Illinois, Inc., in Orange County, and the Ord Mountain mine of Calspar Corp., in San Bernardino County. Output declined 6% in tonnage and 9% in value from that of 1976. Most of the production was used in steelmaking with the rest used in making sanitary and enamel ware.

Gypsum.—California has dropped to third place in mining of crude gypsum in the United States. Production of crude gypsum declined slightly (1%) to 1,629,000 tons while value increased 8% over that of 1976 to $8.5 million. Crude gypsum was mined at five locations in four counties: United States Gypsum Co. at Plaster City, Imperial County; Fannin-Superior Gypsum Co., and H. M. Holloway, Inc., in Kern County; Victor Material Co., Amboy, San Bernardino County; and California Portland Cement Co., San Diego County.

Calcined gypsum was produced at seven locations: Pacific Coast Building Products, Alameda County; The Flintkote Co., Blue Diamond, Butte County; Kaiser Gypsum Co., Inc., Contra Costa County; National Gypsum Co., Contra Costa County; United States Gypsum Co., Imperial County; Kaiser Gypsum Co., Inc., Los Angeles County; and National Gypsum, Los Angeles County.

Most of the byproduct gypsum came from three plants: Valley Nitrogen Producers, Inc., in Fresno County; Occidental Petroleum Corp., in San Joaquin County; and Allied Chemical Corp. in Contra Costa County.

Hydrogen Sulfide.—Hydrogen sulfide was produced as a byproduct of oil refining at two plants. Total production declined 12% while value increased 50% compared with that of 1976.

Lime.—Lime production declined slightly (6%) to 598,000 tons in 1977 but value increased 3% to $24 million. The Flintkote Co., U.S. Lime Div., produced quicklime and hydrate at its plants in Richmond, Contra Costa County and City of Industry, Los Angeles County. Holly Sugar Corp. produced quicklime at plants in Hamilton, Glenn County; Brawley, Imperial County; Santa Ana, Orange County; and Tracy, San Joaquin County. Kaiser Aluminum & Chemical Corp. and Amstar Corp. produced quicklime at Spreckels and Natividad, Monterey County; Pfizer, Inc., MPM Div., produced quicklime at Lucerne, San Bernardino County. Kerr-McGee also had a plant in San Bernardino County producing quicklime and hydrate. Other companies producing quicklime were Union Sugar Co. at Betteravia, Santa Barbara County; Merck Chemical Co., Sonora, Tuolumne County; and American Crystal Sugar Co. and Amstar Corp. in Clarksburg and Woodland, Yolo County. Ninety-two percent of the lime was produced as quicklime and the remainder as hydrate. Lime was used to precipitate magnesia from seawater, sugar refining, soil stabilization, refractories, and other miscellaneous uses.

Lithium Compounds.—Kerr-McGee Chemicals Corp., the State's only lithium producer, recovered lithium carbonate by flotation from dilithium sodium phosphate from Searles Lake brines at Trona, San Bernardino County. Output of production was down 2% from that of 1976 and value decreased 27%.

Magnesium Compounds.—Output increased 5% and value increased 20% compared with that of 1976. Magnesium was produced from seawater at three plants. Kaiser Aluminum & Chemical Corp. continued to be the major producer of magnesium compounds, producing caustic-calcined magnesia, refractory magnesia, and magnesium-hydroxide at its plant in Monterey County. Merck & Co., Inc., produced extra-light, light, and heavy magnesium oxide, magnesium hydroxide, and magnesium carbonate at its plant in San Mateo County. Western Magnesium Corp. produced magnesium chloride crystal at its plant in San Diego County.

Peat.—Production and value of peat declined 8% in quantity and 10% in value from that of 1976. Two mines were active. Radel, Inc., near Likely, Modoc County, produced moss peat, and Delta Humus Co. produced reed-sedge peat near Holt, San Joaquin County. Most of the peat moss was used as a soil amendment.

Perlite.—Crude perlite production increased 46% and value increased 66% over that of 1976. All of the State's production came from the American Perlite Co.-Redco, Inc., Fish Springs mine at Big Pine, Inyo County. A total of 42,000 tons of expanded perlite, an increase of 48%, was produced in five plants in Los Angeles County, four in San Bernardino County, and one in Sonoma County. Twenty-seven percent was used in filters, 22% in horticulture, 20% in construction aggregates, and the rest in miscellaneous uses including roof insulation board.

Phosphate Rock.—A small amount of phosphate rock was produced by the California Phosphate Co. from the Cuyama mine in Santa Barbara County. Production declined 56% and value declined 58% from that of 1976.

Potassium Salts.—Output of potassium salts, all from the Kerr-McGee Chemical Corp. operation at Trona, San Bernardino County, was down 9% in quantity, as measured by K_2O equivalent, and down 11% in value. Marketed products were potassium sulfate, which contained 51.5% K_2O equivalent, and standard, course, and chemical muriate, which contained 61.1%, 61.2%, and 63.1% K_2O equivalent, respectively.

Pumice.—Combined output of crude and prepared pumice, pumicite (volcanic ash), and scoria decreased 10% and value increased 18% over that of 1976. It was produced by 32 operators from 84 mines and 17 plants in 13 counties. Ninety percent of the production came from five counties: Lake, Modoc, San Bernardino, Shasta, and Siskiyou.

The material was composed of pumice and pumicite, 63,000 tons (10%); volcanic cinder, 462,000 tons (73%); volcanic tuff, less than 1,000 tons; and scoria, 111,000 tons (17%). The principal uses were road building, 277,000 tons (44%); concrete aggregate, 142,000 tons (22%); landscaping, 123,000 tons (19%); other uses, 82,000 tons (13%); and railroad ballast, 12,000 tons (2%). Other uses included roofing granules, soil conditioner, fill, abrasive compound, pesticide carrier, and building block veneer.

Salt.—Salt output declined 21% in quantity but increased 5% in total value compared with that of 1976. All of the salt sold or used in California in 1977 was produced as evaporated salt except for a small quantity of rock salt produced by Leslie Salt Co. in San Bernardino County and small quantities of brine produced by Imperial Thermol Products, Inc., in Imperial County and by Occidental Petroleum Chemical Co. in San Bernardino County. All of the salt produced by evaporation was recovered by using the solar evaporation process except for a small quantity recovered by the vacuum pan process by Leslie Salt Co. in Alameda County. Leslie Salt Co., with operations in Alameda, Napa, San Bernardino, and San Mateo Counties, was the State's leading salt producer. Other salt producers were Western Salt Co., in Kern County; Occidental Petroleum Chemical Co., Pacific Salt and Chemical Co., Southwest Salt Co., and Standard Salt Co. in San Bernardino County; Oliver Bros. Salt Co. in Alameda County; and Imperial Thermol Products, Inc., in Imperial County.

Sand and Gravel.—California continued to be a leading producer of sand and gravel in 1977. Production increased 13% in quantity and 24% in value over that of 1976. Production of 109,135,000 short tons of sand and gravel valued at $250,951,000 was reported in 1977 from 427 mines operated by 300 companies in 52 counties. Half of the total production came from 110 mines located in the five counties of the Los Angeles-San Diego area: Los Angeles County (19%), San Diego County (10%), Orange County (8%), Riverside County (7%), and San Bernardino County (6%).

More than 98% of the total production was sold as construction-grade material at an average unit value of $2.20 per short ton. Industrial-grade material amounting to less than 2% of the total production was produced by 12 companies at an average unit value of $8.00 per short ton.

Of the construction-grade material, 45% was marketed as sand with a unit value of $2.07 per short ton and 55% as gravel with a unit value of $2.31 per short ton. More than half (54%) was used as concrete aggregate, 19% was used as roadbase material, 16% as asphalt concrete aggregate, and 7% as fill. The remaining 4% was used in concrete products, railroad ballast, and miscellaneous uses.

Most (68%) of the industrial-grade sand was used in the manufacture of glass, 9% was used in sand blasting, and 3% in moldmaking. The remaining 20% was used in abrasives, hydrafrac, metallurgy, and other miscellaneous uses.

Five companies each with an output of more than 5 million tons accounted for 36% of the total production of construction-grade material; the next 14 companies each with an output of 1 million tons per year or more accounted for an additional 26%; the next 20 companies with 500,000 tons or more brought the cumulative production for these 39 companies to 76% of the total. The remaining 24% was produced by 249 companies. The top 10 companies in terms of production were Conrock Co., Kaiser Industries Corp., Livingston-Graham, Inc., Owl Rock Products Co., Lone Star Industries Inc., Blue Diamond Materials, A. Teichert & Son, Inc., C. L. Pharris Trucking, Transit Mix Concrete, and Southern Pacific Milling Co. Together, these companies accounted for 50% of the sand and gravel produced in the State in 1977. Seven companies, each with production of 100,000 tons per year or more, produced 96% of the industrial-grade sand in 1977. The top three companies were Owens-Illinois, Inc., Ottawa Silica Co., and Del Monte Properties Co.

Table 7.—California: Sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	48,463	$100,309	$2.07
Gravel	58,851	136,084	2.31
Total[1] or average	107,314	236,392	2.20
Industrial sand	1,820	14,558	8.00
Grand total[1] or average	109,135	250,951	2.30

[1] Data may not add to totals shown because of independent rounding.

Table 8.—California: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	57,633	$134,276	$2.33
Concrete products (cement blocks, bricks, pipe, etc.)	3,256	8,211	2.52
Asphaltic concrete aggregates and other bituminous mixtures	16,967	38,909	2.29
Roadbase and coverings	20,383	39,766	1.95
Fill	7,724	10,103	1.31
Railroad ballast	157	470	3.00
Other	1,195	4,658	3.90
Total[1] or average	107,314	236,392	2.20

[1] Data may not add to totals shown because of independent rounding.

Sodium Carbonate.—Production of sodium carbonate (soda ash) decreased 4% but value increased 4% in 1977. Production of sodium sulfate (salt cake) declined 5% in quantity and 15% in value of output compared with that of 1976. Kerr-McGee recovered both products from Searles Lake brines at its Trona and Westend plants in San Bernardino County. An expansion project was completed at the Searles Lake operations to increase soda ash production from 150,000 to 1,300,000 tons per year. Feed for the expansion will come from deep wells in Searles Lake rather than shallow wells which provided feed for the Trona and Westend plants. Sodium sulfate production will be increased by 150,000 tons per year at Trona.

Stone.—Eighteen companies quarried dimension stone at 23 quarries for rough blocks (44%), rough construction stone (32%), dressed construction stone, and other uses. Output doubled to 25,654 tons valued at $996,000. Leading producers were V & M

Quarry Co., Vic Williams Stone Co., and Santa Maria Stone Co. Crushed stone was produced by 96 companies at 511 quarries for cement manufacture, roadbase aggregate, other aggregate and roadstone, and other uses. Output increased 5% to 34 million tons valued at $80 million. Leading producers were Kaiser Cement & Gypsum Corp., and Amcord, Inc.

Among the States, California ranked second in output of miscellaneous dimension and crushed stone, third in crushed sandstone, and third in dimension marble.

Limestone ranked first in total production in 1977 with 17.2 million tons valued at $40 million. Traprock was second with 5.4 million tons valued at $13 million, granite was third at 4.7 million tons valued at $13 million, and sandstone was fourth with 2.6 million tons valued at $5 million. Shell, marble, slate, and miscellaneous stone made up the remaining 4 million tons production.

Table 9.—California:Crushed stone,[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Cement manufacture	10,530	18,470	12,693	23,550
Dense-graded roadbase stone	5,600	11,760	7,707	17,684
Roadstone	2,960	5,338	3,598	6,690
Concrete aggregate	2,815	6,070	2,619	6,084
Bituminous aggregate	3,034	8,718	1,876	4,626
Roofing granules	753	1,672	933	2,261
Lime manufacture[2]	1,458	4,005	727	2,204
Riprap and jetty stone	1,892	5,287	639	2,160
Fill	894	1,391	523	1,014
Glass manufacture	416	3,010	395	3,021
Macadam aggregate	384	1,035	358	1,032
Surface treatment aggregate	31	50	257	680
Other filler	201	1,434	218	1,614
Mineral food	114	780	133	899
Terrazzo and exposed aggregate	141	1,243	131	1,336
Filter stone	54	131	113	281
Whiting	102	1,370	W	W
Flux stone	W	W	50	113
Agricultural limestone	35	194	29	159
Bedding material	77	252	W	W
Acid neutralization	--	--	2	33
Abrasives	(3)	(3)	--	--
Other uses[4]	867	2,336	1,008	4,704
Total[5]	32,364	74,548	34,011	80,146

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, traprock, granite, miscellaneous stone, sandstone, marble, and shell.

[2] Includes dead-burned dolomite and sugar refining.

[3] Less than 1/2 unit.

[4] Includes stone used for ferrosilicon, railroad ballast, asphalt filler, soil conditioners, mine dusting (1977), refractory stone (1976), unspecified uses, and uses indicated by symbol W.

[5] Data may not add to totals shown because of independent rounding.

Sulfur.—Byproduct sulfur was recovered at 14 refineries, 4 in Contra Costa County, 9 in Los Angeles County, and 1 in Solano County. The leading producers were Chevron U.S.A., Inc., at refineries at Richmond, Contra Costa County, and El Segundo, Los Angeles County, followed by Union Oil Co. of California, Oleum refinery in Contra Costa County; Mobil Oil Corp. at Torrance, Los Angeles County; Atlantic Richfield Co., at Watson, Los Angeles County; Exxon Co., U.S.A. at Benicia, Solano County; and Texaco, Inc., at Long Beach, Los Angeles County. Total production was 499,000 long tons valued at $9.4 million compared with 432,000 long tons valued at $7.9 million in 1976.

Talc and Soapstone.—Production of talc increased 68% to 95,602,000 tons in 1977 after several years of declining production. Value increased 57% to $2,373,000. Production was reported from 13 mines, 7 in Inyo County, 5 in San Bernardino County, and 1 mine in El Dorado County. Major producers were Pfizer, Inc., with three mines in Inyo County and two mines in San Bernardino County, and Cyprus Industrial Minerals Co., with one mine in Inyo County. Ground and prepared material was used in ceramics, paints, refractories, paper, and miscellaneous uses.

Vermiculite.—Production of exfoliated vermiculite derived from crude vermiculite mined in Montana and South Carolina decreased 14% and total value decreased 50% over that of 1976. Average unit value decreased 41%. The major producers were W. R. Grace & Co. with three plants, one each in Orange (Santa Ana), Alameda (Newark), and Los Angeles (Los Angeles) Counties; and La Habra Products, Inc., in Anaheim, Orange County. Major uses included fireproofing, 34%; concrete aggregate, 23%; horticulture, 17%; loose fill, 11%; soil conditioner, 8%; and plaster aggregate, premix, block insulation, and other uses, 7%.

METALS

Copper.—Production of recoverable copper was down 41% in quantity and 44% in value compared with that of 1976, reflecting the worldwide depression in the copper market. The major producer was the Pine Creek mine of Union Carbide as a byproduct of tungsten mining. Smaller amounts were produced in the Zaca mine in Alpine County and Monte Cristo mine in Mono County as a byproduct of gold and silver mining.

Table 10.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing[1]		Material sold or treated[2] (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1975, total	10	6	29,200	9,606	$1,551,270	79,757	$352,527
1976, total	12	4	10,213	10,392	1,302,327	57,265	249,104
1977:							
Fresno	--	--	--	713	105,745	97	448
San Joaquin	--	--	--	281	41,675	25	116
Stanislaus	--	--	--	699	103,669	61	282
Trinity	--	1	--	7	1,038	--	--
Tuolumne	1	--	10	6	890	--	--
Undistributed[3]	5	--	4,511	3,998	592,943	57,708	266,612
Total	6	1	4,521	5,704	845,960	57,891	267,458

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	344	$441,151	66	$28,186	206	$160,763	$2,533,897
1976, total	375	521,546	54	24,937	170	125,924	2,223,838
1977:							
Fresno	--	--	--	--	--	--	106,193
San Joaquin	--	--	--	--	--	--	41,791
Stanislaus	--	--	--	--	--	--	103,951
Trinity	--	--	--	--	--	--	1,038
Tuolumne	--	--	--	--	--	--	890
Undistributed[3]	221	294,549	3	2,030	2	1,344	1,157,478
Total	221	294,549	3	2,030	2	1,344	1,411,341

[1] Operations from which gold and silver are recovered as byproducts from sand and gravel operations not counted as producing mines.

[2] Does not include gravel washed.

[3] Alpine, Butte, Inyo, Mono, Plumas, Sacramento, and Sierra Counties combined to avoid disclosing company proprietary data.

Table 11.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated[2] (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold, gold-silver, tungsten[3]	6	[4]4,521	2,494	57,689	221	3	2
Placer	1	--	3,210	202	--	--	--
Total	7	4,521	5,704	57,891	221	3	2

[1] Operations from which gold and silver are recovered as byproduct from sand and gravel operations and copper recovered as byproduct from tungsten operations are not counted as producing mines.

[2] Does not include gravel washed.

[3] Combined to avoid disclosing company proprietary data.

[4] Excludes tungsten ore tonnage.

Table 12.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation, cyanidation, and direct smelting of ore[1]	1,521	5,392	([2])	1	--
Smelting of concentrates[3]	973	52,297	221	3	2
Total lode material	2,494	57,689	221	[4]3	2
Placer	3,210	202	--	--	--
Grand total	5,704	57,891	221	3	2

[1] Combined to avoid disclosing company proprietary data.

[2] Less than 1/2 unit.

[3] Includes byproduct recovery from tungsten ore.

[4] Data do not add to total shown because of independent rounding.

Gold.—Gold production declined 45% compared with that of 1976, but its value declined only 35% because of the higher per unit value. Of the total production of 5,704 troy ounces, 2,494 troy ounces came from lode mines and 3,210 troy ounces from placer mines. The bulk of the placer gold came from eight operations that recovered gold as a byproduct to sand and gravel washing operations and were not classed as mining operations. A small quantity of gold was produced at the single placer operation classified as a mine. Dragline dredging was used in six of the plants, nonfloating washing plants were used in two plants, and one mine used suction dredging. Sacramento County produced the greatest amount of placer gold followed by Stanislaus, Fresno, San Joaquin, and Trinity Counties. Major lode gold producers included the Dickey Exploration Co.'s Oriental mine in Sierra County; Claude B. Lovestedt's Zaca mine in Alpine County; Ras Mining's Imperial mine in Plumas County; and, as a byproduct of tungsten mining, Union Carbide Corp.'s Pine Creek mine in Inyo County. Although only a token amount of gold was produced compared with past production, interest in gold mining has increased substantially because of the rise in price. The State contains more than 25,000 mines of record and thousands of prospects in approximately 400 mining districts throughout the State. Numerous groups, including major mining companies, are renewing exploration activities in the old mining districts. In addition, considerable weekend recreational prospecting was reported.

Iron Ore and Concentrates.—Usable iron ore shipments to consumers, which included direct shipping ore, concentrates, and agglomerates declined 11% in quantity and 4% in value in 1977. The major producer was Kaiser Steel Corp. at its Eagle Mountain mine in Riverside County. According to Kaiser Steel Corp.'s annual report, reserves at the company's open pit iron mine at Eagle Mountain were estimated to be adequate to supply Fontana's four blast furnaces for approximately 20 years. An underground deposit at Eagle Mountain would be adequate, if economically minable, to provide iron ore for an estimated additional 10 years of operation. During 1977, approximately 67% of the iron ore shipped from Eagle Mountain was in the form of pellets. The pellet plant is currently operating near its full 2.5-million-ton annual capacity. The ore was treated and concentrates and agglomerates were shipped to the company's plant at Fontana, Riverside County. In addition to the Eagle Mountain mine, Standard Slag Co. produced iron ore concentrates from the Beck mine in San Bernardino County, and California Portland Cement Co. produced a small amount of direct shipping ore from the Baxter mine in San Bernardino County for use in cement manufacture.

Iron Oxide Pigments.—Production of finished (synthetic and natural) iron oxide pigments increased 38% and value increased 52% over that of 1976. Much of the increase came in synthetic red iron oxide. All of the material was produced at the Emeryville plant of Pfizer, Inc., in Alameda County.

Iron and Steel.—Kaiser Steel Corp. is the largest steel producer located in the Western United States and is the only mine-to-metal steelmaker in California. The company is the 10th largest producer of steel in the Nation, manufacturing about 2% of the total raw steel output. Its principal markets are in the States of Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington, which currently represent about 8% of the national market down from 8.5% to 9% during the 1960's and early 1970's reflecting a decline in heavy construction. According to Kaiser Steel Corp.'s annual report, its share of the Western States market is about 17%, down from 19% in 1976.

Work on Kaiser Steel Corp.'s $233 million modernization program at the Fontana works began in 1975 and is now about 80% complete. In the past, the plant has operated at about 40% open hearth and 60% basic oxygen. Completion of the modernization program will result in a 100% oxygen process plant. Also, a continuous slab caster now being installed will enable the company to make higher quality steel. In addition to the modernization program, the company is implementing air control programs on both the steelmaking and coke oven operations at a cost of $103 million over the next 5 years to meet the stringent air quality standards in the Los Angeles Basin.

Iron and Steel Slag.—A total of 763,723 tons of iron and steel slag was produced in 1977. Most of it (48%) was used as roadbase, 16% was used as railroad ballast, 11% as asphaltic concrete aggregate, 8% in concrete aggregate, 6% in sewage treatment, and the remainder in roofing and fill.

Lead and Zinc.—Lead production declined 94% in quantity and 92% in value, and zinc production declined 99% in both quantity and value. The small amount that was produced was derived as a byproduct of tungsten and gold-silver mining.

Molybdenum.—The output of molybdenum in the form of oxide and sulfide concentrates increased 43% in quantity and 59% in value in 1977. The entire amount was recovered as a byproduct of treating tungsten ore from the Pine Creek mine in Inyo County by Union Carbide.

Rare-Earth Minerals.—Molycorp, Inc., continued to produce most of the Nation's output of rare-earth oxides from its mine located at Mountain Pass, San Bernardino County. Production of bastnäsite increased 9% and value increased 34% in 1977. Bastnäsite, the primary mineral, is mined by open pit and milled to produce three grades of concentrates: 60% REO (rare-earth oxide) unleached, 70% REO leached, and 90% REO calcined. The concentrate is further processed to produce concentrates of cerium (65% to 70% CeO_2) and lanthanum (75% LaO_3). An electronic-nuclear-phosphor-grade of pure europium oxide is also produced. Concentrates of neodymium-praseodynium and gadolinium-samarium can also be produced if desired.

Lanthanum and cerium chemicals are used mainly in oil refining, catalysts, container glass, ductile iron, and glass-polishing compounds. Samarium is used in permanent magnets, gadolinium is a nuclear reactor control material, and europium oxide is used in color television phosphors.

Silver.—Silver production in 1977 increased slightly 2% to 58,000 ounces while its value increased 7% to $267,000 reflecting the increase in unit price. A small amount (202 ounces) of silver is produced in conjunction with the recovery of placer gold but most is produced as a coproduct or byproduct of lode mine operation. The major sources of silver were the Pine Creek mine of Union Carbide in Inyo County as a coproduct of tungsten mining, Claude B. Lovestedt's Zaca mine in Alpine County as a coproduct with gold, and the Monte Cristo mine of Monte Cristo Mining Enterprises in

Mono County as a coproduct of gold mining.

Tungsten.—California led the Nation in the production of tungsten concentrates producing nearly two-thirds of the total domestic output. The State's tungsten production increased a little more than 1% and total value increased 48% compared with that of 1976. Most of the State's production came from three mines, the Pine Creek mine in Inyo County owned by Union Carbide Corp., the Tungsten Peak mine in Kern County owned by Tungsten Peak Mines, and from a mine in San Bernardino County owned by Eurocal Minerals, Inc. The remaining production came from 22 mines in Fresno, Inyo, Kern, Los Angeles, San Bernardino, and Tulare Counties. Most of the ore and concentrates were sent to the Union Carbide plant at Pine Creek or to the Kennametal, Inc., plant in Churchill County, Nev., for upgrading.

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[1] State Liaison Officer, Bureau of Mines, Sacramento, Calif.

[2] California Division of Oil and Gas, Publication No. PRO6, 1977.

[3] California Oil Producers, Annual Review 1977.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos:			
Atlas Asbestos Corp	Box 805 Coalinga, CA 93210	Open pit mine	Fresno.
Calaveras Asbestos Corp	Box 127 Copperopolis, CA 95228	do	Calaveras.
Boron minerals and compounds:			
American Borate Corp	Star Route 15, Box 610 Lathrop Wells, NV 89020	do	Inyo.
U.S. Borax & Chemical Corp	Box 75128 Sanford Station Los Angeles, CA 90005	do	Kern.
Calcium chloride:			
National Chloride Co. of America.	615 South Flower St. Suite 803 Los Angeles, CA 90017	do	San Bernardino.
Cement:			
Amcord, Inc.[1]	610 Newport Center Dr. Newport Beach, CA 92660	Plants	Riverside and San Bernardino.
California Portland Cement Co.[1]	800 Wilshire Blvd. Los Angeles, CA 90017	do	Kern and San Bernardino.
General Portland, Inc.[1]	3810 Wilshire Blvd. Los Angeles, CA 90005	do	Kern.
Kaiser Cement & Gypsum Corp.[2]	300 Lakeside Dr. Oakland, CA 94612	do	San Bernardino and Santa Clara.
Monolith Portland Cement Co.[1]	3326 San Fernando Rd. Los Angeles, CA 90065	do	Kern.
Southwestern Portland Cement Co.[1]	1034 Wilshire Blvd. Los Angeles, CA 90017	do	San Bernardino.
The Flintkote Co.[3]	San Francisco, CA 94104	do	Calaveras and Shasta.
Clays:			
Homestake Mining Co	Port Costa, CA 94569	Pit	Contra Costa.
Interpace Corp	2901 Los Feliz Blvd. Los Angeles, CA 90039	Pit	Amador, Placer, Riverside, Sutter, Yuba.
Lightweight Processing Co	650 South Grand Ave. Los Angeles, CA 90017	Pit	Ventura.
Pacific Clay Products Co	1255 West 4th St. Los Angeles, CA 90017	Pit	Amador, Orange, Riverside.
Diatomite:			
Grefco, Inc	630 Shatto Pl. Los Angeles, CA 90005	Open pit mine	Santa Barbara.
Johns-Manville Sales Corp	Lompoc, CA 93436	do	Do.
Feldspar:			
Calspar Corp	12402 Los Nietos Rd. Santa Fe Springs, CA 90670	do	San Bernardino.
Gold:			
Dickey Exploration Co	Box K Alleghany, CA 95910	Lode mine	Sierra.
Gypsum:			
Fannin-Superior Gypsum Co	Rt. 1, Box 7, Hwy. 46 Wasco, CA 93280	Open pit mine	Kern.
H. M. Holloway, Inc	714 6th St. Wasco, CA 93280	do	Do.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	Open pit mine and plant.	Imperial.

See footnotes at end of table.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Iron ore:			
Kaiser Steel Corp	Box 158 Eagle Mountain, CA 92241	Open pit mine and plant	Riverside.
Lime:			
Amstar Corp	50 California St. San Francisco, CA 94106	Plants	Monterey and Yolo.
Holly Sugar Corp	Box 1052 Colorado Springs, CO 80901	do	Glenn, Imperial, Orange, San Joaquin.
Magnesium compounds:			
Kaiser Aluminum & Chemical Corp.[4]	Moss Landing, CA 95039	do	Monterey.
Merck & Co., Inc.[4]	Rahway, NJ 07065	do	San Mateo.
Natural gas liquids:			
Atlantic Richfield Co.[5]	445 South Figueroa St. Los Angeles, CA 90054	do	Kern, Santa Barbara, Ventura.
Union Oil Co. of California[5]	Box 7600 Los Angeles, CA 90054	do	Various.
Peat:			
Delta Humus Co	Box 89 Holt, CA 95234	Bog	San Joaquin.
Radel, Inc	Box 7075 Reno, NV 89502	Bog	Modoc.
Perlite (crude):			
American Perlite Co	11831 Vose St. North Hollywood, CA 91605	Open pit mine	Inyo.
Perlite (expanded):			
Harborlite Corp	Box 458 Escondido, CA 92025	Plant	San Diego.
Paramount Perlite Co., Inc	Box 83 Paramount, CA 90723	do	Los Angeles.
Redco, Inc	11831 Vose St. North Hollywood, CA 91605	do	Do.
Petroleum and natural gas:[6]			
Phosphate rock:			
California Phosphate Co	3838 Carson St. Suite 220 Torrance, CA 90503	Open pit mine	Santa Barbara.
Pumice:			
Cinder Products Co	3450 Lakeshore Ave. Oakland, CA 94610	do	Lake.
Featherrock, Inc	2890 Empire St. Box 6190 Burbank, CA 91510	Pit	Mono.
Hitchcock Bros. Cinders, Inc.	Point Lakeview Rd. Lower Lake, CA 95457	Pit	Lake.
Lavic Stone Corp	Ludlow, CA	Plant	Do.
Red Lava Products of California.	Star Route Clearlake, CA 95423	do	Do.
U.S. Pumice Co	Box 6190 Burbank, CA 91510	Pit	Mono.
Rare-earth minerals:			
Molycorp, Inc	Nipton, CA 92366	Open pit mine	San Bernardino.
Salt:			
Leslie Salt Co.[7]	505 Beach St. San Francisco, CA 94111	Solar evaporators	Alameda, Napa, San Bernardino, San Mateo.
Sand and gravel:			
Conrock Co	Box 2950, Terminal Annex Los Angeles, CA 90051	Pits	Los Angeles, Orange, San Bernardino.
Kaiser Industries Corp.[2]	300 Lakeside Dr. Oakland, CA 94612	do	Alameda, Contra Costa, Glenn, Santa Clara.
Livingston-Graham, Inc	13550 Live Oak Ave. Irwindale, CA 91706	do	Los Angeles, Orange, Ventura.
Owl Rock Products Co	Box 47 Irwindale, CA 91707	do	Fresno, Los Angeles, Orange, Riverside.

See footnotes at end of table.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Pacific Cement & Aggregates[2]	400 Alabama St. San Francisco, CA 94110	Pits	Alameda, Fresno, Monterey, Sacramento, San Joaquin, San Mateo, Santa Cruz, Tulare, Yolo.
Silver:			
Claude B. Lovestedt[8]	Box 1496 Carson City, NV 89701	Underground mine	Alpine.
Sodium carbonate, sodium sulfate:			
Kerr-McGee Chemical Corp.[9]	Box 367 Trona, CA 93562	Plant	San Bernardino.
Stone:			
Basalt Rock Co., Inc	Box 2540 Napa, CA 94558	Quarry	Marin, Napa, Sonoma.
East Bay Excavating Co	28814 Mission Blvd. Hayward, CA 94544	do	Kern and San Bernardino.
Granite Rock Co	Box 151 Watsonville, CA 95076	do	San Benito.
Talc:			
Pfizer, Inc.[4]	Box 558 Lucerne Valley, CA 92356	Open pit mines	Inyo and San Bernardino.
Tungsten:			
Union Carbide Corp.[10]	270 Park Ave. New York, NY 10017	Underground mine	Inyo.

[1] Also clays and stone.
[2] Also stone.
[3] Also clays, sand and gravel, lime, and stone.
[4] Also lime.
[5] Also petroleum and natural gas.
[6] Most of the major oil and gas companies and many smaller companies operate in California; several commercial directories contain lists of them.
[7] Also calcium compounds.
[8] Also gold, copper, lead, and zinc.
[9] Also borate minerals and potassium salts.
[10] Also crude asbestos, copper, gold, silver, and molybdenum.

The Mineral Industry of Colorado

By Karl E. Starch[1] and Peggy A. Walker[2]

The value of mineral production in 1977 was $1.4 billion, an increase of 26% over the 1976 value. Most of this increase was the result of higher prices paid for mineral commodities; 23 commodities increased in value, while 6 declined. The most substantial price increases occurred in coal, natural gas, natural gas liquids, lead, molybdenum, tungsten, uranium, clays, gypsum, lime, and pumice. A lesser portion of the increase in value of minerals produced in 1977 over 1976 is attributed to increased production. Production increased for 17 commodities, while production decreases occurred in 10 commodities. Clays, feldspar, gold, pumice, pyrites, salt, sand and gravel, and uranium had the largest percentage increases in output. Price and quantity declined in copper, peat, and zinc, while a decline in output despite no change or an increase in price occurred in cement, gypsum, industrial sand and gravel, lead, lime, and tungsten.

Twenty-nine mineral commodities were produced in Colorado in 1977, unchanged from 1976. Of these, 13 were classified as nonmetals, 11 as metals, and 5 as fuels. Metals accounted for 31% of the total mineral value, fuels 59%, and nonmetals 10%. Based on value, the leading commodity in each group was molybdenum, petroleum, and cement, respectively. Nineteen of the 29 mineral commodities produced in the State had a value of over $1 million; 15 of these were valued at over $10 million, including 4 that were valued at over $100 million.

Colorado ranked first in the Nation in production of molybdenum and tin, second in production of tungsten and vanadium, and third in the production of lead and silver.

Table 1.—Mineral production in Colorado[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide _____thousand cubic feet__	317,720	W	W	W
Clays[2] _________ thousand short tons__	479	$1,976	961	$4,712
Coal (bituminous) ____________do____	9,437	144,364	11,989	201,289
Copper[3] _______________short tons__	2,431	3,384	1,896	2,533
Gem stones ______________________	NA	142	NA	100
Gold[3] ________________troy ounces__	50,764	6,362	72,668	10,777
Gypsum ________ thousand short tons__	215	984	211	1,121
Lead[3] _________________short tons__	26,749	12,358	22,994	14,118
Lime __________ thousand short tons__	185	4,406	180	5,413
Natural gas ________million cubic feet__	183,972	88,307	188,792	152,922
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels__	1,904	13,403	9,381	67,066
LP gases ________________do____	6,505	38,249		
Peat __________ thousand short tons__	33	238	32	195
Petroleum (crude) thousand 42-gallon-barrels__	38,992	376,273	39,460	398,457

See footnotes at end of table.

Table 1.—Mineral production in Colorado[1] —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel[4] --- thousand short tons--	20,160	$32,900	23,910	$50,527
Silver[3] -------- thousand troy ounces--	4,083	17,762	4,663	21,545
Stone:				
Crushed ------ thousand short tons--	5,293	12,357	5,597	14,169
Dimension---------------do----	6	198	5	181
Zinc[3] ----------------short tons--	50,621	37,460	40,267	27,704
Combined value of carbon dioxide, cement (masonry and portland), clays (bentonite), feldspar, iron ore, molybdenum, perlite, pumice, pyrites, salt, sand and gravel (industrial), tin, tungsten concentrate, uranium, vanadium---------------------	XX	319,043	XX	424,210
Total----------------------	XX	1,110,166	XX	1,397,039
Total 1967 constant dollars --------	XX	399,105	XX	[P]689,578

[P]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes bentonite; value included in "Combined value" figure.

[3]Recoverable content of ores, etc.

[4]Excludes industrial sand and gravel; value included in "Combined value" figure.

Table 2.—Value of mineral production in Colorado, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams----------------	$58,134	W	Sand and gravel, lime, stone.
Alamosa---------------	W	$229	Sand and gravel, peat.
Arapahoe --------------	22,113	3,550	Sand and gravel, stone.
Archuleta--------------	486	W	Sand and gravel.
Baca -----------------	2,981	3	Stone.
Bent -----------------	880	--	
Boulder ---------------	21,601	28,993	Cement, sand and gravel, stone, clays, lime, gold, silver, peat, tungsten, lead, zinc, copper.
Chaffee ---------------	W	W	Stone, sand and gravel, peat.
Cheyenne --------------	6,876	6	Sand and gravel.
Clear Creek-------------	W	W	Molybdenum, sand and gravel, gold, lead, silver, copper, stone.
Conejos ---------------	W	W	Sand and gravel.
Costilla ---------------	W	W	Pumice, sand and gravel.
Crowley ---------------	19	19	Sand and gravel.
Custer ----------------	W	W	Perlite.
Delta-----------------	W	W	Sand and gravel, lime, stone.
Denver----------------	W	81	Sand and gravel, stone.
Dolores ---------------	2,553	256	Sand and gravel, stone, silver, zinc, gold, lead, copper.
Douglas ---------------	608	W	Clays, sand and gravel, stone.
Eagle-----------------	W	W	Zinc, silver, lead, sand and gravel, copper, gold, pumice, stone.
Elbert ----------------	1,359	331	Sand and gravel, clays.
El Paso ---------------	W	W	Sand and gravel, stone, clays.
Fremont---------------	39,715	39,647	Cement, stone, gypsum, clays, sand and gravel, feldspar.
Garfield ---------------	2,221	672	Sand and gravel, stone, vanadium, uranium.
Gilpin ----------------	W	W	Peat.
Grand ----------------	441	488	Sand and gravel.
Gunnison --------------	100	W	Stone, sand and gravel.
Hinsdale --------------	W	1	Sand and gravel.
Huerfano --------------	119	101	Do.
Jackson ---------------	5,734	28	Sand and gravel, stone.
Jefferson --------------	W	W	Sand and gravel, uranium, stone, clays.
Kiowa ----------------	5,285	--	
Kit Carson ------------	W	W	Sand and gravel.
Lake -----------------	214,538	230,171	Molybdenum, tungsten, silver, zinc, lead, gold, tin, sand and gravel, copper, pyrites, stone.
La Plata---------------	21,335	544	Sand and gravel, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Colorado, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Larimer	$18,251	$19,122	Cement, sand and gravel, stone, gypsum, lime.
Las Animas	W	W	Sand and gravel, clays, stone.
Lincoln	W	65	Sand and gravel.
Logan	11,726	W	Lime, sand and gravel.
Mesa	7,333	W	Uranium, sand and gravel, vanadium, stone.
Mineral	W	W	Silver, lead, zinc, copper.
Moffat	17,226	W	Uranium, sand and gravel, vanadium, stone.
Montezuma	2,761	W	Sand and gravel, carbon dioxide, stone.
Montrose	W	27,314	Uranium, vanadium, sand and gravel, salt, stone.
Morgan	7,301	W	Lime, sand and gravel, stone.
Otero	603	W	Lime, sand and gravel.
Ouray	6,576	3,116	Zinc, lead, silver, copper, gold, sand and gravel.
Park	W	W	Peat, sand and gravel, stone.
Phillips	64	46	Sand and gravel.
Pitkin	4,067	W	Iron ore, sand and gravel.
Prowers	982	140	Sand and gravel, stone.
Pueblo	W	W	Lime, sand and gravel, clays, stone.
Rio Blanco	227,506	W	Sand and gravel.
Rio Grande	W	W	Do.
Routt	1,885	432	Sand and gravel, stone.
Saguache	W	W	Uranium.
San Juan	W	15,883	Zinc, gold, lead, silver, copper.
San Miguel	33,324	W	Uranium, vanadium, zinc, lead, copper, gold, silver, sand and gravel, stone.
Sedgwick	W	W	Lime, sand and gravel.
Summit	714	800	Sand and gravel, silver, gold.
Teller	W	W	Peat, silver, sand and gravel, stone.
Washington	22,363	32	Sand and gravel, stone.
Weld	102,811	W	Sand and gravel, lime, stone.
Yuma	W	378	Sand and gravel.
Undistributed[2]	237,573	1,024,585	
Total[3]	1,110,166	1,397,039	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Values for petroleum are based on an average price per barrel for the State.

[2] Includes gem stones, coal, natural gas, natural gas liquids, petroleum, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Colorado business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,213.0	1,250.0	+3.0
Unemployment	do	71.0	78.0	+9.9
Employment (nonagricultural):				
Mining	do	21.2	23.[illegible]	+9.4
Manufacturing	do	141.1	144.4	+2.3
Contract construction	do	49.6	51.7	+4.2
Transportation and public utilities	do	60.3	62.6	+3.8
Wholesale and retail trade	do	236.2	240.9	+2.0
Finance, insurance, real estate	do	59.0	61.0	+3.4
Services	do	193.0	194.7	+.9
Government	do	214.2	213.8	-.2
Total nonagricultural employment	do	974.6	992.3	+1.8
Personal income:				
Total	millions	$16,810	$18,752	+11.6
Per capita		$6,527	$7,160	+9.7
Construction activity:				
Number of private and public residential units authorized		24,951	37,281	+49.4
Value of nonresidential construction	millions	$300.8	$431.2	+43.4
Value of State road contract awards	do	$69.0	$135.0	+95.7
Shipments of portland and masonry cement to and within the State	thousand short tons	1,227	1,445	+17.8
Mineral production value:				
Total crude mineral value	millions	$1,110.2	$1,397.0	+25.8
Value per capita, resident population		$430	$533	+23.9
Value per square mile		$10,649	$13,401	+25.8

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Legislation and Government Programs.—During the first session of Colorado's 51st General Assembly (1977), after several years of debate, a bill imposing a mineral severance tax was passed. Governor Richard D. Lamm refused to sign the bill, and it became law without his signature on January 1, 1978. This act, 39-29-101 et. seq. CRS 1973, imposes new taxes on metals, molybdenum, coal, and oil shale and increases the previous tax on oil and gas. Nonmetals were not included in the law. Metals, exclusive of molybdenum, are taxed at a rate of 2.25% of gross income per mining operation (defined as mine-mouth value) exceeding $11 million, with a credit for ad valorem taxes assessed not to exceed 50% of the severance tax. Income from the extraction or processing of ores or minerals from mine waste or residue of previously processed ores is not included. Molybdenum is taxed at a rate of 15 cents per ton of ore mined without credits or exemptions. Coal is taxed at a rate of 60 cents per ton for surface-mined coal and 30 cents per ton for underground-mined coal, with a provision for increasing or decreasing the rate 1% for every three points' change in the index of wholesale prices. The first 8,000 tons of coal produced each quarter is exempt, and there is an additional 50% credit on the production of lignitic coal. Oil shale is taxed at a rate escalating to 4% of gross proceeds (defined as mine-mouth value) in the fourth and succeeding years of a commercial (50% of design capacity) oil-shale activity. There are exemptions for the first 10,000 barrels per day of production and a 25% credit for the use of in situ methods. Oil and gas are taxed at a rate varying with the gross income (defined as wellhead value), ranging from 2% for under $25,000 to 5% for over $300,000. Wells producing less than 10 barrels per day of crude oil (stripper wells) are exempt. A credit against the severance tax is allowed in an amount equal to 87-1/2% of all ad valorem taxes assessed. Severance tax receipts are to be distributed 40% to the State's general fund, 15% to the severance trust fund, and 45% to the local government tax fund.

The State of Colorado and the U.S. Department of the Interior signed a cooperative agreement authorizing the State to enforce surface mining reclamation standards on Federal coal leases. This agreement is intended to prevent duplication in the administration and enforcement of State and Federal reclamation laws and is similar to agreements between the Department of the Interior and the States of Wyoming, Utah, New Mexico, North Dakota, and Montana. According to the U.S. Geological Survey, there are 113 Federal coal leases in Colorado covering 121,470 acres, containing an estimated 271 million tons of coal recoverable by surface mining methods. Twelve of these leases are currently in production.

The Colorado State Government proposed a pioneering process to evaluate the environmental and socioeconomic aspects of Climax's Mt. Emmons molybdenum project near Crested Butte. The State's proposal has been termed the Colorado Review Process (CRP) and would identify all Federal, State, and local agencies that should be involved early in the planning and conceptual process of mine development and would coordinate their activities and that of the local citizens in reviewing and issuing necessary permits and in drafting complete and comprehensive environmental impact statements. Climax has agreed to participate in CRP and has pledged full cooperation in making this new coordination process a success. The U.S. Forest Service is the lead Federal agency, and the Colorado Department of Natural Resources is the lead State agency in this evaluation process.

As part of a major experiment to examine environmental problems of deep oil shale mining, the Federal Bureau of Mines drilled a 10-foot-diameter, 2,371-foot-deep shaft on Horse Draw in the Piceance Creek basin. Drilling, started on March 25, 1977, was interrupted by two major fishing operations to recover lost tools and was completed on October 2, 1977. The shaft was lined with 8-foot-diameter steel casing, and work on hoisting equipment and surface facilities was begun.

The Colorado Legislature passed and Governor Lamm signed into law legislation establishing a new State system for receiving and distributing mineral lease revenues from Federal land in Colorado which are returned by the Federal Government to the State. The measure brings State law into compliance with changes made by Congress in 1976 to the 1920 Mineral Leasing Act. These changes, among other things, increased the State share of revenues from Federal lands from 37-1/2% to 50%. Included in the bill is a new local government mineral impact fund to aid communities suffering growth impact from energy or mineral resource development projects. Under the formula established in the bill, the $15 million in Federal leasing revenue expected by the State in fiscal 1978 would be distributed as follows: $9 million to the State school fund, $2.3 million to counties in which the lease revenue originated, $1.5 million to the Colorado Water Conservation Board for small water projects, and $2.2 million to the new mineral impact fund.

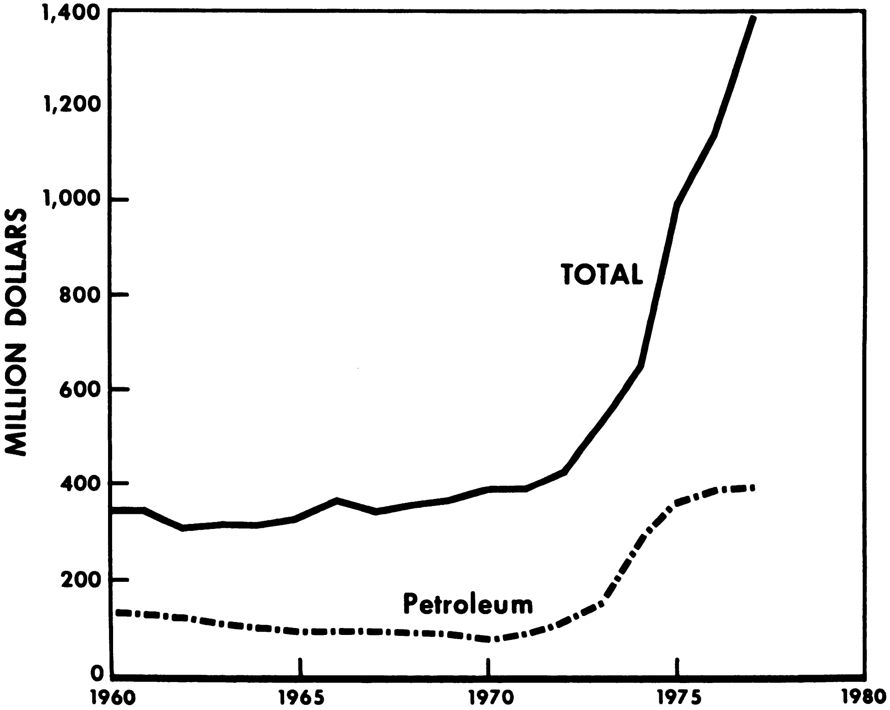

Figure 1.—Value of petroleum and total value of mineral production in Colorado.

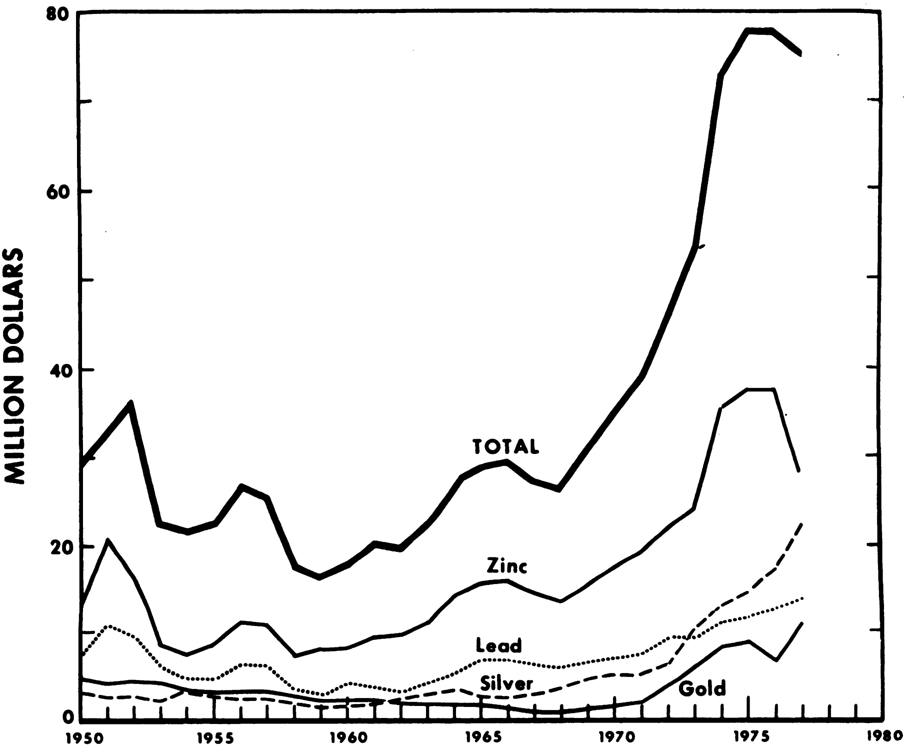

Figure 2.—Value of mine production of gold, lead, silver, and zinc, in Colorado.

REVIEW BY MINERAL COMMODITIES

METALS

Cadmium, Indium, and Thallium.—ASARCO Inc. recovered cadmium, indium, thallium metal, and thallous sulfate at its Globe smelter in Denver from flue dust, dross, and byproduct materials received from out-of-State smelters. The output was not included in the State mineral production because the origin of the processed materials could not be determined. Cadmium is contained in some zinc ores mined in Lake, Ouray, San Juan, and San Miguel Counties.

Copper.—Copper production decreased 22% in quantity and 25% in value compared with that of 1976. The value decline reflected lower prices paid for copper; the average price paid for copper in 1977 was 66.8 cents per pound compared with 69.6 cents per pound in 1976. Copper in Colorado is obtained principally from base metal ores in lode mines. The State placed 10th in the Nation in the production of copper.

The decline in output was caused by decreases in copper production at the Idarado mine of Idarado Mining Co. in Ouray and San Miguel Counties and the Camp Bird mine of Federal Resources Corp. in Ouray County. Camp Bird mine sustained an 82% drop in copper output. However, Idarado, despite a 39% decline in copper output, remained the largest copper producer in the State. To lower operating costs and conserve reserves at the Idarado mine, the work force was reduced in early October from approximately 285 workers to about 145. Employment in 1975 had been 489 employees. High mining costs, lower metal prices for copper and zinc, and lower grade ores contributed to the $302,000 net loss reported by the company in 1977.[3] The Camp Bird mine suspended operations early in August and placed the mine and mill on a limited standby basis. Thirty employees were laid off, and 15 were retained to stockpile ore, maintain the equipment and pumps, and conduct a limited exploration program.

The Sunnyside mine of Standard Metals Corp. on Cement Creek north of Silverton, San Juan County, was again the second largest copper producer. The Idarado, Sunnyside, and Eagle mines accounted for 85% of the State's output of copper. Ten other mines reported copper output; of these, principal production was obtained from the Eagle mine of New Jersey Zinc Co. at Gilman, Eagle County, the Bulldog Mountain mine of Homestake Mining Co. at Creede, Mineral County, the Leadville unit of ASARCO Inc. at Leadville, Lake County, and the Camp Bird mine unit of Federal Resources, Inc. There were six small mines with copper production in 1977, compared with seven in 1976. Only two of the six small mines with copper output in 1977 were among those in production in 1976. This low survival rate of small mines between 1976 and 1977 was characteristic of all the base metals.

Table 4.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing[1]		Material sold or treated[2] (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1975, total	22	4	1,400,255	55,483	$8,959,946	3,366,000	$14,877,723
1976, total	21	2	1,294,584	50,764	6,361,745	4,083,171	17,761,795
1977:							
Clear Creek	3	--	943	141	20,911	1,940	8,963
Eagle	1	--	164,708	905	134,220	238,414	1,101,473
Ouray	2	--	70,941	1,259	186,722	69,115	319,311
San Juan	7	--	268,957	49,410	7,327,998	329,968	1,524,452
San Miguel	1	--	257,262	7,183	1,065,311	186,021	859,418
Summit	--	--	1	1	148	71	328
Undistributed[3]	5	1	458,828	13,769	2,042,081	3,837,967	17,731,407
Total[4]	19	1	1,221,640	72,668	10,777,391	4,663,496	21,545,352

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	3,560	$4,570,975	27,088	$11,647,675	48,460	$37,798,934	$77,855,253
1976, total	2,431	3,384,109	26,749	12,357,980	50,621	37,459,873	77,325,502
1977:							
Clear Creek	2	2,516	23	14,254	--	--	46,644
Eagle	166	222,394	1,778	1,091,776	11,767	8,095,365	10,645,228
Ouray	183	244,849	1,286	789,441	2,151	1,479,849	3,020,172
San Juan	502	670,974	4,824	2,962,162	4,939	3,398,130	15,883,716
San Miguel	801	1,070,327	4,831	2,966,244	8,799	6,053,744	12,015,044
Summit	--	--	--	--	--	--	476
Undistributed[3]	241	322,204	10,252	6,294,585	12,611	8,676,563	35,066,840
Total[4]	1,896	2,533,264	22,994	14,118,462	40,267	27,703,651	76,678,120

[1] Operations from which gold, silver, copper, lead, or zinc were recovered as byproducts from sand and gravel, or cleanup, are not counted as mines.

[2] Does not include gravel washed.

[3] Includes Boulder, Dolores, Gilpin, Lake, and Mineral Counties.

[4] Data may not add to totals shown because of independent rounding.

Table 5.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc, in 1977, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation and cyanidation[1]	25,408	157,046	--	--	--
Smelting of concentrates	46,711	4,364,623	1,777	22,974	40,267
Direct smelting of:					
Ore	482	141,756	120	20	--
Cleanup	1	71	--	--	--
Total[2]	72,602	4,663,496	1,896	22,994	40,267
Placer	66	--	--	--	--
Grand total	72,668	4,663,496	1,896	22,994	40,267

[1] Combined to avoid disclosing company proprietary data.
[2] Data may not add to totals shown because of independent rounding.

Table 6.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material

Source	Number of mines[1] [2]	Material sold or treated[3] (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Silver[4]	7	276,862	870	3,681,587	256	2,586	1,172
Copper-lead-zinc	1	300,750	8,397	217,467	937	5,648	10,286
Lead	4	1,229	147	2,822	2	24	--
Lead-zinc	7	482,937	62,764	664,891	654	12,979	17,042
Zinc	1	159,861	423	96,658	47	1,758	11,767
Total[5]	13	944,777	71,731	981,838	1,640	20,408	39,095
Silver cleanup	--	1	1	71			
Total lode	18	1,221,640	72,602	4,663,496	1,896	22,994	40,267
Placer	1	--	66	--	--	--	--
Grand total	19	1,221,640	72,668	4,663,496	1,896	22,994	40,267

[1] Detail will not necessarily add to totals shown because some mines produce more than one class of material.
[2] Operations from which gold and silver are recovered as byproducts from sand and gravel operations, or cleanup, are not counted as producing mines.
[3] Does not include gravel washed.
[4] Includes silver from leach vats.
[5] Data may not add to totals shown because of independent rounding.

Gold.—Output of gold was 21,904 ounces (43%) above the 50,764 ounces recovered in 1976. The 69% increase in value for 1977 was attributed to the gain in average price of gold from $125.32 per troy ounce in 1976 to $148.31 per troy ounce in 1977. Seventeen lode mines and 2 placer operations in 12 counties yielded gold, compared with 20 lode mines and 2 placers in 1976. Most of the gold was recovered as a byproduct of base metal ores. With 6.6% of domestic output, Colorado ranked fifth among the States in production of gold in 1977, compared with 5% of the output and the same rank in 1976.

More than one-half of Colorado's gold production came from the Sunnyside mine of Standard Metals Corp., which continued to be the largest producer of gold in the State. In 1977, production from the Sunnyside increased 86% from that of 1976. The gain in output at the Sunnyside was achieved with improved operating facilities at the mine — the new ore pass and service raise were used during the year, and the expanded mill (from 700 to 1,200 tons per day) allowed a 24% increase in tonnage milled. Value of the ore increased $7.37 per ton because increase in precious metal prices which offset the lower price of zinc and a higher grade ore was mined.[4]

Listed in order of production, other principal gold producers included the Leadville unit of ASARCO Inc., Idarado mine of

Idarado Mining Co., and Eagle mine of New Jersey Zinc Co. The Sunnyside, Leadville unit, and Idarado mines yielded 97% of the gold produced in Colorado.

Texasgulf, Inc., continued exploration for gold on the Golden Cycle Corp. properties in Cripple Creek, Teller County. According to the Golden Cycle Annual Report 1977, the project started January 30, 1976, with an agreement creating the Texasgulf Golden Cycle Mining Co. and was scheduled to expend $3 million in 3 years. By yearend 1977, $3.6 million had been spent.

In the 2 years exploratory drilling was conducted from surface and underground locations, an old hoist at the Ajax mine was replaced by a $300,000 hoist, two large underground ventilation systems were installed on the 3100 level of the Ajax, the Cresson and Vindicator laterals on the 3100 level were cleaned up and rehabilitated, substantial geological mapping was done, hundreds of old mine maps were consolidated, and many samples were taken. Over 55,000 feet of surface drilling was completed; 140 holes drilled to a depth of 400 feet.

Objectives were to find large, low-grade gold mineralization suitable for open pit mining and high-grade veins not previously discovered. Assay results were very low grade except in an area about 800 feet northwest of the Cresson shaft, where a 30-foot intercept assayed 0.41 ounce of gold per ton. From the 3100 level of the Ajax, a total of 3,905 feet in three holes were drilled on the downward extension of the productive Newmarket and Bobtail veins. On the Bobtail, one hole tested 460 feet below the 3100 level was low grade. At 325 feet below the 3100, another hole intercepted the Newmarket vein. One hot spot had values of 69.65 ounces of gold per ton over a true thickness of 3.6 feet. Another structure 100 feet distant over a true thickness of 3.6 feet showed values of 1.40 ounces of gold per ton. The second hole intercepted the Newmarket about 500 feet below the 3100 level and had a true thickness of 7.3 feet assaying 0.73 ounce of gold per ton, a more typical finding.

In 1977, about 10,000 feet of underground tunnels were rehabilitated in order to provide access to the ends of two long lateral tunnels. In the 1940's and 1950's, these laterals had been driven toward the lower levels of the Cresson and the lower levels of the Vindicator-Theresa-Golden Cycle mines; a point below the Vindicator shaft was reached, but the Cresson lateral was stopped 1,200 feet from a point vertically below the Cresson shaft. Texasgulf was preparing to map, sample, and drill the area by 1978.[5]

The Mining Record, March 9, 1977, reported that Pennsylvania Mountain Associates operated a gold placer at 12,400 feet in the Mosquito Range south of Fairplay, Colo. Discovered in 1870, the Bulgar basin placers are operated only during the summer months owing to severe working conditions such as permafrost, muskeg, 75- to 80-mile-per-hour winds, and maximum 55° to 60° F summer temperatures.

In other developments, Tusco, Inc., purchased the Allied Chemical Corp. fluorspar mill in Boulder. Hendricks Mining Co., owners of the Cross mine in Caribou, Boulder County, will operate and manage the mill in order to process the gold-silver ore from the Cross mine and some custom ores.

Among the 10 counties with gold production during 1977, San Juan, Lake, San Miguel, and Ouray were leading sources; their production accounted for 98% of the State's output. There were 12 small mines (material treated or sold under 50,000 tons per year) with gold production, compared with 14 in 1976. Of the 14 small mines with gold output in 1976, only 3 were among the 12 small mines in production in 1977.

Iron Ore.—The Cooper mine south of Ashcroft, Pitkin County, is the only operation currently producing iron ore in the State. Owned by Pitkin Iron Corp. and operated by Morrison-Knudsen Co., Inc., this mine produces ore that is trucked to a railhead north of Aspen and then shipped to CF&I Steel Corp.'s Pueblo smelter.

Lead.—Output of lead decreased 14%; however, the value of production increased 14% owing to the increase in the price of lead. The average price for the year was 30.7 cents per pound, 7.6 cents above the average price for 1976. In 1977, Colorado ranked third in the Nation, producing 3.9% of domestic lead; in 1976, the State produced 4.4%.

The Leadville unit of ASARCO Inc. continued to have the largest production of lead ore in the State. Idarado mine of Idarado Mining Co. retained second place even with a decrease in output of lead ore. In order of production, other principal producers included the Sunnyside mine, Standard Metals, Inc.; the Bulldog Mountain mine, Homestake Mining Co.; the Eagle mine, New Jersey Zinc Co.; the Sherman mine, Day Mines, Inc.; and the Camp Bird mine, Federal Resources Corp.

Six of 10 counties with lead production had output over 1,000 short tons of lead. Ranked according to amount, the counties were Lake, San Miguel, San Juan, Mineral, Eagle, and Ouray. Eleven small mines contributed 1,107,818 pounds of lead, or 2.4% of the State's production in 1977, compared with the same number producing 3,270,523 pounds of lead, or 6.1%, in 1976. Of the small mines producing lead in 1977, only three were in operation in 1976; the other eight were new producers.

Pride of the West mill near Silverton was reopened in April 1977. Union Supply Co. purchased the mill from the Dixilyn Corp. in 1976 and formed the San Juan Milling Co. to operate the plant as a custom mill for the treatment of copper, lead, zinc, gold, and silver ores. Built in 1941, this standard flotation mill was processing about 60 tons of ore per day by July 1977; full capacity of the mill is reportedly 600 to 700 tons per day. The company planned to obtain 70% to 75% of the mill feed from ores mined from various rehabilitated old mines. San Juan reopened the Esmeralda by removing 30 to 40 feet of caved material. Mining, exploration, and development was also started at the Henrietta using conventional mining methods and an innovative Swedish-made tunneling machine that bores a drift 5 feet wide and 7-1/2 feet high.

Molybdenum.—Molybdenum was once again the most valuable metal produced in Colorado. Climax Molybdenum Co., a division of AMAX Inc. and the Nation's largest molybdenum producer, reported 75 million pounds of molybdenum in concentrate produced in 1977 from its Climax and Henderson[6] mines. The Henderson underground mine in Clear Creek County, in its first full year of production, increased output to 24 million pounds of molybdenum from its 1976 level of 3 million pounds. Capacity is expected to reach 50 million pounds of molybdenum in concentrates by 1980. Henderson's reserves, estimated in AMAX's 1977 Annual Report, are 266 million tons of ore averaging 0.421% molybdenum disulfide with a preliminary estimate of an additional 154 million tons containing 0.362% molybdenum disulfide.

The Climax mine, Lake County, molybdenum-in-concentrate production was down 16% from 1976 levels to 51 million pounds because of lower grade ore. The Climax open pit reserves are estimated to be 171 million tons of ore with an average grade of 0.299% molybdenum disulfide. Reserves that could be mined by underground methods are estimated to be 305 million tons containing 0.313% molybdenum disulfide.

Work continued in 1977 on the Mayflower project at the Climax operation. The estimated $30 million project includes constructing a new tailings storage area, an ion-exchange plant, and a heavy metals plant, and relocating 4.5 miles of Colorado Highway 91.[7] The new tailings storage pond will allow continued operations into the 21st century.[8] The ion-exchange plant will remove dissolved molybdenum from excess tailings pond waters, and the heavy metals plant will remove heavy metal ions, such as copper, lead, zinc, and iron, from these waters. The resulting purified water will be released into Ten Mile Creek. The highway is being relocated because the existing highway will be covered by the tailings storage area.

The American Society for Metals designated the Climax mine as a National Historic Landmark. The Climax operation is the first mine in Colorado and 1 of only 13 mines in the United States to be given this recognition.[9]

AMAX and Timberline Minerals, Inc., each performed exploration work for molybdenum on separate prospects near Crested Butte.[10] AMAX's Mt. Emmons prospect is reported to have 165 million tons of mineralized material containing more than 0.43% molybdenum disulfide.[11]

Silver.—Output of silver from 19 mines in 10 counties gained 580,325 troy ounces, or 14%, over 1976. Value of production increased 21% and was attributed in part to the rise in the average price of silver from $4.35 per troy ounce in 1976 to $4.62 per troy ounce in 1977.

In 1977, with 12% of the Nation's silver output, Colorado ranked third in the Nation; in 1976, the State had 11.9% and ranked third. Six mines had production exceeding 100,000 ounces of silver. Principal output continued to come from Homestake Mining Co.'s Bulldog Mountain mine near Creede and from the Sherman mine operated by Day Mines, Inc., near Leadville. In order of output, other important silver mines included the Sunnyside mine of Standard Metals, Inc., the Leadville unit of ASARCO Inc., the Eagle mine of New Jersey Zinc Co., and the Idarado mine of Idarado Mining Co. These mines accounted for almost 99% of the State's output of silver. Leading counties, in order of production, were Mineral, Lake, San Juan, Eagle, and San Miguel. Thirteen small mines had silver production in 1977, compared with 14 in 1976; however, only 3 of those small mines with silver output in 1977 were the same ones in production in 1976.

According to the Homestake Annual Report 1977, ore milled at the Bulldog Mountain mine increased from 105,752 tons in 1976 to 113,672 tons in 1977. Silver content of the ore increased from 18.1 ounces per ton in 1976 to 19 ounces per ton in 1977. Production was obtained from six stopes above and nine stopes below the 9360 level which is the main access tunnel level at 9,360 feet above sea level. By yearend, over 8-1/2 miles of tunnel had been driven on five separate levels. During the year, 7,013 feet of development drifts were driven and 2,315 feet of raises bored. Development work was concentrated in the Puzzle vein system on the 9000, 9200, and 9360 levels. Exploration included drifting on the West Strand vein system on the 9360 level and long-hole diamond drilling to test for parallel structures east and west of the Puzzle system. Significant ore-grade mineralization was encountered in the West Strand structure and excellent-grade ore on vein intercepts, assuring continuity of ore between 9000 and 9200 levels. The newly constructed carbon-in-pulp plant, first in the world, required modifications of equipment and processes which necessitated operating the plant at lower-than-expected tonnages. Most modifications, however, were completed by yearend. The electrolytic section of the plant was found to be underdesigned, and modifications were expected to be completed in 1978. The added capacity will permit reprocessing of the silver-bearing material from the tailings pond. By December, the startup of a newly constructed water treatment plant was expected to improve the quality of the mine water discharge.

The Sherman mine, Leadville unit, Day Mines, Inc., according to the 1977 Annual Report, increased the amount of ore processed in the mill 59% in 1977. The 85,066 tons of ore treated averaged 21.45 ounces of silver per ton and 1.13% lead per ton, and 40% more silver was recovered than in 1976. During the year, mine plant improvements included installation of trackless mucking ahd haulage equipment, construction of a new change room, and relocation of the compressor. Additional mill facilities to be completed by mid-1978 will provide concentrating tables and a thickener. Day Mines, Inc., had nearly recovered all of its costs in the project by yearend, and accumulation of work capital began. With the establishment of a working capital fund equal to 3-month average operating costs, the 50-50 split with Leadville Corp. of the first $4 million of operating costs will commence. Thereafter, profits over $4 million will be split 60% to Day Mines and 40% to Leadville.

In other developments, Rico Argentine Mining Co. suspended mining and milling operations at the Rico mine in Rico early 1977, until milling procedures could be studied. Exploration by core drilling in the area continued.

Tin.—Tin concentrate was produced as a byproduct at AMAX's Climax mill. Production amounted to 171,000 pounds of tin contained in concentrates.[12]

Tungsten.—Most of the tungsten produced in Colorado comes from the Climax mine of AMAX Inc. About 2.2 million pounds of tungsten trioxide in concentrate was produced as a byproduct of processing molybdenum ore. This was approximately the same level as 1976.[13] Colorado Tungsten Corp. in Boulder County and Choctaw Mining Co. in San Juan County mined small amounts of tungsten ore.

Uranium.—For the first time in 3 years, the output of uranium oxide in the State increased. Production of U_3O_8 increased 20% over that of 1976 and value rose 45%, reflecting both the increased price of yellowcake and the increased production. Colorado maintained fourth place behind New Mexico, Wyoming, and Utah in ranking among producing States. Uranium production came from 82 mines in 7 counties during the year; 2 in Garfield, 1 in Jefferson, 19 in Mesa, 3 in Moffat, 36 in Montrose, 2 in Saguache, and 19 in San Miguel.

Operators of the four uranium mills in Colorado in 1977 were the Cotter Corp. at Canon City, Union Carbide at Uravan, Sweeney Mining and Milling Co. in Boulder County, and Ranchers Exploration and Development Co. In addition, Cotter Corp. awarded a $26.1 million contract to Mountain States Engineering Corp. for the design and construction of a new uranium-vanadium processing facility at Canon City.

Homestake Mining Co. continued work on its Pitch project near Marshall Pass in Saguache Co. According to Homestake's 1977 annual report, drilling thus far has indicated 2.3 million tons of ore with a grade of 0.19% U_3O_8. The company has signed contracts for delivery of 6.3 million pounds of yellowcake, which is to be produced at the open pit operation. The annual report also indicated that the necessary licenses and permits have been obtained from the appropriate State and Federal agencies and that the U.S. Forest Service is preparing an environmental statement on the project. The company announced plans to begin construction of a mill in 1979.

Ranchers Exploration and Development Corp. began moving old mill tailings from a site near the San Miguel River at Naturita to a new site about 2.5 miles away. The 600,000 tons of tailings were leached to remove the less than 1 pound of U_3O_8 contained in each ton; the uranium in the leachate was then recovered by solvent extraction. The processed tailings were covered to provide environmental protection. The first yellowcake was recovered in December. When operations were completed at the Naturita site in late 1978, it was planned to disassemble the mill and relocate it at Durango to begin processing an additional 1.4 million tons of abandoned tailings there. The uranium produced from the operation has been sold to Virginia Electric and Power Co. of Richmond, Va.

Other uranium developments around the State include plans for a uranium ore-crushing and sampling plant near Whitewater in Mesa County. The new plant, owned by Cotter Corp., was scheduled for completion in September. Weld County authorities announced in September that they will lease some 40,000 acres of county-owned minerals. Interest centered around the Grover area, where Wyoming Minerals Corp. was testing a deposit to determine whether an in situ leaching project would be economically feasible. Power Resources Corp. of Denver had expressed interest in the Weld County holdings. Power Resources Corp. also announced that it had signed a joint venture with Shell Oil Corp. to explore 80,000 acres in eastern Colorado. Public Service Co. of Oklahoma and Nuclear Dynamics of Phoenix, Ariz., announced a joint venture to explore 20,000 acres of uranium claims in western Colorado. The Energy Reserves Group began producing ore from the Bitter Creek mine in Montrose County in mid-1977. Uranium workers at the Schwartzwalder mine of Cotter Corp. returned to work on August 1, after a strike that began June 27.

Vanadium.—Production of vanadium in Colorado in 1977 increased slightly over that of 1976. Colorado continued to rank second, behind Arkansas, among the five vanadium-producing States in the Nation. San Miguel County led in vanadium production, followed closely by Montrose County. Mesa, Garfield, and Moffat Counties also contributed to the State's total vanadium production.

A representative of Union Carbide Corp. indicated that increased vanadium production reflected the continued recovery in the steel industry.

During the year, Cotter Corp. awarded a contract to Mountain States Engineers to construct a new uranium-vanadium processing facility at Canon City in Fremont County. A vanadium circuit being constructed at the Ranchers Exploration and Development Co.'s Naturita mill, which is currently recovering uranium from abandoned mill tailings, is scheduled to come on-stream in early 1978. The vanadium, in liquid form, would be sent to the Union Carbide mill at Rifle for recovery.

Zinc.—Output of zinc was down 10,354 tons, a 20.5% decrease under production in 1976. Value decreased 26% when the average price for zinc declined to a record low of 34.4 cents per pound. With 9% of the Nation's output in 1977 and 10% in 1976, Colorado ranked fourth among the States in production of zinc for both years.

Eight counties had 13 operating mines. Eagle County ranked first in production, followed, in order of output, by Lake, San Miguel, San Juan, and Ouray Counties. These five counties accounted for over 97% of the State's production.

Of the 12 mines with zinc production, 6 mines had output of over 500 tons of zinc. The largest producers were the Eagle mine of New Jersey Zinc Co. and the Leadville unit of ASARCO Inc. In order of output, principal production of zinc also was obtained from the Idarado mine of Newmont Mining Corp., Sunnyside mine of Standard Metals Corp., Bulldog mine of Homestake Mining Co., and Camp Bird mine of Federal Resources Corp. The Emperius mine, operated by Minerals Engineering Co., near Creede, Mineral County, closed October 1976 and remained closed during 1977. Six small mines had zinc production in 1977 compared with five in 1976; however, of the small mines with zinc output in 1976, only one was among those in production in 1977.

On December 31, 1977, New Jersey Zinc Co. closed its zinc operations at the Eagle mine near Gilman, Eagle County. Reasons given by the company included foreign imports, depressed domestic market, and rising cost of labor. Exploration and mining of copper and silver ore will continue on a limited basis. The mine is one of the last in the country to use underhand square-set mining, which requires extensive hand placing of timber supports.

Beginning in May, a strike at the Bunker Hill Co. zinc plant at Kellogg, Idaho, forced Standard Metals Corp. to stockpile 5,000 tons of zinc concentrates from the Sunnyside mine near Silverton. After the strike ended in October, shipments from the stockpile were slow to resume because zinc quotas were met from mine production.

NONMETALS

Cement.—Portland and masonry cement were produced and shipped by Ideal Cement Co., a division of Ideal Basic Industries, Inc., and Dewey Rocky Mountain Cement Co., a division of Martin Marietta Corp. Production of portland cement was 4% lower than 1976 production, while masonry cement output was 20% above 1976 production. Overall production of cement, portland and masonry, in 1977 was 4% below the 1976 level. At yearend, portland cement stocks at the mills had decreased 30% and masonry cement stocks had decreased 37% compared with 1976. Decreased stocks indicate increased demand for cement by the construction industry. Ready-mix concrete companies purchased 73% of the portland cement production, an increase of 5% over 1976 purchases. Other buyers, in order of quantities purchased, were concrete product manufacturers, contractors, and building materials dealers. Ninety-three percent of the portland cement produced was transported from plants by truck, and the balance moved by rail.

Clays.—Production of clays, exclusive of bentonite, increased 101% in quantity and 140% in value compared with 1976. The increase in output reflected increased demand for clay products by the construction industry. Common clay and shale accounted for 96% of total clay production, and fire clay accounted for 4%.

Clay and shale production in 1977 amounted to 960,644 short tons valued at $4,712,339. The average price per short ton of common clay and shale was $4.88, and fire clay was valued at $5.53 per short ton.

Output of clay came from 55 mines, operated by 16 companies, in 8 counties, compared with 37 mines, 16 companies, and 9 counties in 1976. Twelve companies produced common clay and shale, four produced fire clay, and two produced bentonite.

Common clay and shale were used for making common brick, face brick, and sewer pipe. Fire clay was used for firebrick and flue linings, and bentonite was primarily used as a waterproof sealer.

The largest clay producer, Robinson Brick and Tile Co., operated 10 mines for common clay and shale in Douglas, Elbert, El Paso, and Jefferson Counties. The second largest producer, Summit Pressed Brick and Tile Co., operated one mine in Las Animas County and one mine in Pueblo County.

Table 7.—Colorado: Clays sold or used by producers, by county

County	1976	
	Short tons	Value
Boulder	W	W
Douglas	371,901	$2,238,870
Elbert	15,425	100,263
El Paso	W	W
Fremont	W	W
Jefferson	W	W
Las Animas	20,000	20,000
Pueblo	129,137	290,526
Other counties	447,855	2,340,985
Total[1]	960,644	4,712,339

W Withheld to avoid disclosing company proprietary data; included in "Other."

[1] Excludes bentonite.

Feldspar.—Colonna & Co. produced feldspar by hand cobbing from pegmatites in the Rampart Range, Fremont County. The product was used as decorative stone and crushed rock.

Gypsum.—The Flintkote Co., Joe C. Lackey, Ernest W. Munroe, Colorado Lien Co., and Quad-Honstein Joint Venture mined 210,600 short tons of gypsum in 1977. The first two of these companies are in Fremont County, and the last three are in Larimer County. Output was about equal to 1976 production. The Flintkote Co. calcined gypsum at its Coaldale plant, Fremont County. Output of calcined gypsum increased 16% above that of 1976. Calcined gypsum was used in the manufacture of building products, principally wallboard materials. Uncalcined gypsum was marketed to farm supply stores as a soil conditioner and to cement plants as a cement retarder.

Lime.—CF&I Steel Corp., Great Western Sugar Co., American Crystal Sugar Co., and Holly Sugar Corp. produced lime in 10 counties for steel furnaces, sugar refining, and other uses. Leading counties were Pueblo, Morgan, Otero, and Larimer. Compared to 1976, production decreased 3% to 180,500 tons, but value increased 23%. Output was all used in Colorado.

Peat.—Compared with 1976, peat output was down 3% in quantity and 18% in value. Eight producers mined 32,200 tons of peat in six counties. Park County had the most production, followed by Teller County. Two producers operated in Teller County, two in Park, and one each in Alamosa, Boulder, Chaffee, and Gilpin Counties. Six of the operations produced moss-type peat, which accounted for 73% of total production. Humus and reed-sedge types accounted for 24% and 3%, respectively. Average value of peat sold in 1977 was $6.09, down $1.12 from 1976. Most of the output, 26,660 tons, was shipped in bulk; the rest was packaged. Sixty-eight percent of production, 21,800 tons, was used for general soil improvement, and the remainder was used for other purposes.

Perlite.—The only crude perlite produced in Colorado was mined at the Rosita mine of Persolite Products, Inc., in Custer County. Output was equal to that of 1976. Production from the mine was shipped to the company's expanding plant near Florence. Perlite was expanded at two mills in Colorado: the Antonito in Conejos County, operated by Grefco, Inc., and the Florence in Fremont County, operated by Persolite Products, Inc. Source of the crude perlite for the Grefco, Inc., mill was deposits in New Mexico.

Expanded perlite was used principally as material for filter aids (90%). Other uses included concrete, plaster, horticulture aggregate, and low-temperature insulation.

Pumice.—In comparison with 1976, output of pumice, in the form of volcanic cinders and scoria, increased 25%, and value increased 300%. Scoria was produced by Colorado Aggregate Co., Inc., at its Mesita Hill mine in Costilla County, and volcanic cinder was mined by Dotsero Block Co., Inc., near Gypsum in Eagle County. About 60% of production was utilized in landscaping. Other uses included concrete aggregate, road construction, and roofing granules.

Pyrites.—Output of pyrites, produced as a byproduct at AMAX Inc.'s Climax mill, increased 32% over the 1976 level.

Salt.—Salt in the form of brine was recovered from a well in Montrose County by Union Carbide Corp. for use in the company's uranium-vanadium mill at Uravan. Production increased by 22%, and value was 15% above that of 1976.

Sand and Gravel.—Output of sand and gravel, excluding that produced for industrial uses, increased 18.6% in quantity and 53.6% in value compared with the 1976 output. The increase in quantity reflects a moderate increase in construction activity, whereas the increase in value reflects to a greater degree an increase in prices. The overall unit price for sand and gravel for construction purposes in 1977 was $2.11 per ton, whereas in 1976 the price was $1.63. Of the 23.9 million tons produced in 1977, 16.1 million tons was gravel and 7.7 million tons was sand.

In the ranking of mineral production based on value, sand and gravel production went from eighth place in 1976 to seventh place in 1977.

During 1977, sand and gravel was obtained from 55 of the 63 counties in the State. No sand and gravel was attributed to Baca, Bent, Custer, Gilpin, Kiowa, Mineral, Saguache, and San Juan Counties. Seven counties—Adams, Arapahoe, Boulder, El Paso, Jefferson, Larimer, and Weld—each had production exceeding 1 million tons and together accounted for 16.3 million tons, or 68% of the State's total production. Boulder County had the most production with 3,355,000 tons, displacing Jefferson County, which had been the leading county for the past 3 years.

Seventy-one percent of the construction sand and gravel was classified as commercial; the 29% classified as noncommercial was produced by governmental agencies, either by their employees or by contractors. The 1977 sand and gravel production for construction purposes came from 203 operations, 28 fewer than in 1976.

Some sand was mined during 1977 for industrial uses, mostly for oil hydrofracturing. This production is not included in the sand and gravel production listed in table 1.

About March 1, the State Mined Land Reclamation Board, which was created under the 1976 Mined Land Reclamation Act, announced that sand and gravel operators had until July 1, 1977, to submit applications for permits to operate unlicensed sand and gravel pits, including those operated by county agencies.

Table 8.—Colorado: Sand and gravel sold or used in 1977,[1] by county

County	Number of plants	Number of deposits	Quantity (thousand short tons)	Value (thousands)
Adams	13	14	2,915	$5,846
Alamosa	1	2	150	228
Arapahoe	6	6	1,614	3,546
Archuleta	1	1	W	W
Boulder	9	8	3,355	7,489
Chaffee	2	1	113	140
Cheyenne	1	1	6	6
Clear Creek	1	1	W	W
Conejos	1	1	W	W
Costilla	1	1	56	113
Crowley	1	2	14	19
Delta	7	7	458	800
Denver	--	1	73	80
Dolores	1	1	W	W
Douglas	3	6	484	721
Eagle	3	3	161	505
Elbert	1	2	155	231
El Paso	7	10	1,744	4,160
Fremont	1	3	75	143
Garfield	2	2	W	W
Grand	3	3	229	488
Gunnison	1	1	W	W
Hinsdale	--	1	--	1
Huerfano	2	4	46	101
Jackson	1	2	17	26
Jefferson	15	16	3,337	6,810
Kit Carson	3	3	W	W
Lake	2	2	178	317
LaPlata	5	4	324	540
Larimer	14	15	1,852	4,006
Las Animas	1	1	W	W
Lincoln	3	3	43	65
Logan	2	2	46	72
Mesa	9	9	978	1,743
Moffat	4	4	547	1,474
Montezuma	3	4	190	466
Montrose	2	2	W	W
Morgan	5	4	134	296
Otero	3	3	126	214
Ouray	2	4	63	96
Park	--	1	2	3
Phillips	1	1	33	46
Pitkin	1	1	100	175
Prowers	2	3	79	137
Pueblo	5	6	877	2,112
Rio Blanco	2	2	W	W
Rio Grande	1	1	W	W
Routt	3	6	235	431
San Miguel	2	2	53	80
Sedgwick	1	1	30	31
Summit	4	5	280	800
Teller	--	2	9	W
Washington	1	2	25	32
Weld	8	8	1,402	3,169
Yuma	2	2	252	378
Undistributed	--	--	1,050	2,391
Total[2]	175	203	23,910	50,527

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Excludes industrial sand and gravel.

[2] Data may not add to totals shown because of independent rounding.

Table 9.—Colorado: Construction sand and gravel sold or used by producers in 1977, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Concrete aggregate	8,681	21,493
Concrete products	337	788
Asphaltic concrete	3,060	6,583
Roadbase and coverings	8,845	16,603
Fill	1,275	1,473
Railroad ballast	27	67
Other uses	1,685	3,520
Total	23,910	50,527

Stone.—Stone production amounted to 5.6 million short tons, 6% higher than production in 1976. Ninety-six quarries in 34 counties produced stone valued at $14,349,767.

Nine companies produced dimension stone at 11 quarries for use primarily as rubble, rough construction stone, and house stone veneer. Output decreased 17% to 4,896 short tons valued at $181,175. Leading producers were Berthoud Pink Stone Co., H. Cobb, and John W. Fitts.

Crushed stone was produced by 19 companies at 85 quarries for cement, concrete aggregate, roadbase aggregate, flux stone, and other uses. Leading producers were Ideal Basic Industries, Cooley Gravel Co., and Martin Marietta Corp.

Sulfur.—Continental Oil Co. recovered elemental sulfur from acid gases at its petroleum refinery near Denver. Elemental sulfur was not included in table 1 because it is considered a secondary product.

Vermiculite.—Crude vermiculite from Montana was exfoliated by W. R. Grace & Co. at its plant in Denver. The product was used for concrete and plaster aggregates, insulation, fireproofing, and horticulture.

MINERAL FUELS

Mineral Fuels.—Coal, crude petroleum, natural gas, and natural gas liquids represented more than one-half of the value of Colorado's mineral production in 1977. Coal production increased approximately 26% over that in 1976, natural gas production 3%, natural gas liquids 12%, and production of crude petroleum slightly more than 1%.

The Secretary of the Department of the Interior approved the detailed development plans submitted by Occidental Oil Shale, Inc., and Ashland Oil Shale, Inc., lessees of Tract C-b, and by Rio Blanco (Gulf Oil Corp. and Standard Oil Co. of Indiana), lessee of Tract C-a. Meanwhile, as part of a major experiment to examine environmental problems of oil-shale mining, the Federal Bureau of Mines drilled an 8-foot-diameter, 2,371-foot-deep shaft on Horse Draw in the Piceance Creek basin, from which four underground levels will be mined.

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[1] Economist, State Liaison Office, Denver, Colo.

[2] Liaison program assistant, State Liaison Office, Denver, Colo.

[3] Newmont Mining Corp. Annual Report 1977.

[4] Standard Metals Corp. Annual Report 1977.

[5] Golden Cycle. Annual Report 1977.

[6] AMAX Inc. 1977 Annual Report. P. 6.

[7] Climax Molybdenum Co. The Mayflower Project. Hi Grade, v. 25, No. 87, Nov. 4, 1977.

[8] U.S. Bureau of Mines. Minerals in the Economy of Colorado. State Mineral Profile, 1978, p. 7.

[9] Leadville Herald Democrat. Historical Landmark Award for Climax Mine. Sept. 8, 1977.

[10] Denver Post. Timberline Running Molybdenum Tests. Nov. 6, 1977.

[11] AMAX Inc. 1977 Annual Report. P. 22.

[12] Page 5 of work cited in footnote 9.

[13] AMAX Inc. 1977 Annual Report. P. 9.

Table 10.—Colorado: Stone sold or used by producers, by county

County	1976			1977		
	Number of quarries	Short tons	Value (thousands)	Number of quarries	Short tons	Value (thousands)
Adams	6	9,307	$18	2	62	(1)
Arapahoe	3	337	1	2	2,003	$4
Boulder	13	1,033,559	1,411	10	991,764	1,365
Clear Creek	--	--	--	1	5	(1)
Delta	--	--	--	1	3,250	13
Denver	2	7,084	14	1	499	1
Dolores	5	31,192	80	5	W	W
Douglas	6	12,362	39	4	W	W
Eagle	2	2,128	4	4	10,472	21
Elbert	2	841	2	--	--	--
El Paso	12	739,212	1,640	4	W	W
Fremont	7	1,650,220	3,425	4	1,568,715	4,288
Garfield	3	77,389	211	5	71,003	170
Grand	3	672	1	--	--	--
Gunnison	5	51,082	52	4	147,052	368
Huerfano	1	213	(1)	--	--	--
Jackson	--	--	--	1	1,030	2
Jefferson	4	807,400	1,655	2	W	W
Kit Carson	1	3,180	6	--	--	--
Lake	--	--	--	1	147	(1)
La Plata	--	--	--	2	1,954	4
Larimer	11	579,133	2,986	16	632,809	2,549
Las Animas	2	876	2	1	27	(1)
Lincoln	6	2,982	6	--	--	--
Mineral	1	47	(1)	--	--	--
Moffat	1	1,463	3	2	178	(1)
Montezuma	1	105	(1)	1	61	(1)
Montrose	1	61	(1)	2	1,231	4
Morgan	--	--	--	2	1,567	3
Prowers	2	4,300	8	1	1,585	3
Pueblo	--	--	--	4	2,933	6
Rio Blanco	2	482	1	--	--	--
Routt	--	--	--	2	693	1
San Juan	1	127	(1)	--	--	--
San Miguel	--	--	--	1	218	(1)
Teller	1	527	1	1	100	(1)
Washington	1	273	1	1	20	(1)
Weld	1	78	(1)	1	4,146	8
Other counties	[2]5	[2]281,981	[2]988	[3]7	[3]2,158,435	[3]5,539
Total[4]	111	5,298,613	12,555	95	5,601,959	14,350

W Withheld to avoid disclosing company proprietary data; included with "Other counties."

[1] Less than 1/2 unit.

[2] Includes Chaffee, Mesa, and Park Counties.

[3] Includes Baca, Chaffee, Mesa, and Park Counties.

[4] Data may not add to totals shown because of independent rounding.

Table 11.—Colorado: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Cement manufacture	2,743	5,431	2,736	6,828
Concrete aggregate	694	1,786	763	2,123
Dense-graded roadbase stone	376	534	486	771
Roadstone	206	518	433	1,143
Bituminous aggregate	211	305	271	619
Riprap and jetty stone	248	667	258	593
Lime manufacture[2]	174	673	102	423
Mineral food	W	W	47	W
Mine dusting	W	W	44	W
Refractory stone	2	W	1	W
Terrazzo	8	17	W	W
Other uses[3]	631	2,426	456	1,668
Total[4]	5,293	12,357	5,597	14,169

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, granite, traprock, and sandstone.

[2] Includes sugar refining.

[3] Includes stone used for flux stone, surface-treatment aggregate, other fillers (1976), waste material (1976), macadam aggregate, railroad ballast (1977), agricultural limestone, filter stone (1976), and uses indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ideal Basic Industries, Inc.[1]	Box 231 Florence, CO 81226	Plants	Fremont and Larimer.
Martin Marietta Corp.[2]	11300 Rockville Pike Rockville, MD 20852		
Clays:			
George W. Parfet Estate, Inc	Box 266 Golden, CO 80401	Mine	Jefferson.
Robinson Brick & Tile Co	Box 1619 Denver, CO 80223	Mines	Douglas, Elbert, El Paso, Jefferson.
Gold: Standard Metals Corp.[3]	Box 247 Silverton, CO 81433	Mine and mill	San Juan.
Gypsum:			
The Flintkote Co	400 Westchester Ave. White Plains, NY 10604	Mine and plant	Fremont.
Ernest W. Munroe	101 E. Vine Dr. Fort Collins, CO 80521	Mine	Larimer.
Quad-Honstein Joint Venture	1301 Arapahoe St. Golden, CO 80401	do	Do.
Iron ore: Pitkin Iron Corp	105 West Adams St. Chicago, IL 60603	Strip mine and plant.	Pitkin.
Lead: ASARCO Inc.[4]	Box 936 Leadville, CO 80461	Mine and mill	Lake.
Lime: The Great Western Sugar Co	Box 5308 Denver, CO 80217	Plants	Adams, Boulder, Larimer, Logan, Morgan, Sedgwick, Weld.
Molybdenum: AMAX Inc.[5]	13949 West Colfax Ave. Golden, CO 80401	Mine	Clear Creek and Lake.
Peat:			
Colorado Peat Industries	6003 Indian Rd. Boulder, CO 80302	Bog	Boulder.
Universal Peat Co	1557 South Ingalls St. Lakewood, CO 80422	Bog	Park.
Ver-Ja Peat Moss	Woodland Park, CO 80863	Bog	Teller.
Marving Enterprises, Inc	304 Mount View Lane Colorado Springs, CO 80907	Bog	Do.
Perlite (crude and expanded):			
Grefco, Inc	Box 308 Antonito, CO 81120	Plant	Conejos.
Persolite Products, Inc.[6]	Box 105 Florence, CO 81226	Mine	Custer.
Pumice:			
Colorado Aggregate Co., Inc	Box 106 Mesita, CO 81142	Strip mine and plant.	Costilla.
Dotsero Block Co., Inc	Box 933 Glenwood Springs, CO 81601	do	Eagle.
Sand and gravel:			
Cooley Sand & Gravel Co.[1]	Box 313 Pueblo, CO 81002	Pits and plants	Adams, Arapahoe, Pueblo.
Golden Gravel Co	Box 328 Longmont, CO 80501	do	Boulder.
Mobile Pre-Mix Sand and Gravel Co	7620 Madison St. Denver, CO 80204	do	Adams and Arapahoe.
Schmidt-Tiago Construction Co., Inc	Box 1149 Sterling, CO 80751	do	El Paso and Moffat.
Western Paving Construction Co	5105 Washington St. Denver, CO 80216	do	Adams.
Silver:			
Day Mines, Inc.[7]	Box D Leadville, CO 80461	Mine and mill	Lake.
Homestake Mining Co.[8]	Box 98 Creede, CO 81130	do	Mineral.
Stone:			
Castle Concrete Co	Box 2379 Colorado Springs, CO 80901	Quarry and plant	El Paso.
Colorado Lien Co	Box 1961 Fort Collins, CO 80521	Quarry	Garfield and Larimer.
Uranium:			
Cotter Corp	Box 352 Golden, CO 80401	Mine	Fremont and Jefferson.
Union Carbide Corp.[9]	270 Park Ave. New York, NY 10017	Mines	Garfield, Mesa, Montrose, San Miguel.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Zinc:			
Idarado Mining Co.[10]	Ouray, CO 81427	Mine and mill	Ouray and San Miguel.
New Jersey Zinc Co.[11]	Gilman, CO 81634	do	Eagle.

[1] Also stone.
[2] Also lime and stone.
[3] Also zinc, lead, silver, and copper.
[4] Also zinc, gold, silver, and copper.
[5] Also pyrites, tin, and tungsten.
[6] Also a plant in Fremont County.
[7] Also lead, zinc, gold, and copper.
[8] Also lead, zinc, and copper.
[9] Also vanadium.
[10] Also lead, gold, and copper.
[11] Also lead, copper, gold, and silver.

The Mineral Industry of Connecticut

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Connecticut Geological and Natural History Survey for collecting information on all minerals except fuels.

By William R. Barton[1]

The value of minerals reported produced in Connecticut was $43.7 million in 1977 compared with $34.3 million in 1976, according to the Federal Bureau of Mines. The increase reflected general inflationary pressures in the national economy and increased production of sand and gravel and stone.

The production of minerals is far less than what is required to sustain the State's economy. The State is self-sufficient only in sand and gravel, feldspar, and certain types of stone, mica, clays, and silica. The State also supplies part of its own needs for lime. Other minerals and mineral-derived materials to sustain the economy are entirely imported. About $14 worth of minerals are produced annually per capita in Connecticut compared with a national average of $356; the value of mineral product per square mile is $8,726 compared with a national average of about $21,324 for nonfuel minerals.

Despite the competitive disadvantages inherent with a lack of indigenous raw materials, much of Connecticut's industry is dependent upon mineral raw materials or intermediate or primary products made directly from minerals (such as cement, aluminum, iron, and steel). The State is the site for important copper and brass milling operations, brick and glass manufacture, and production of diverse items such as concrete products, plastics, chemicals, machine tools and dies, silverware, cutlery, calcium metal, ordnance, hardware, and tools.

A measure of the total importance of minerals and mineral-derived materials in the Connecticut economy may be gleaned from gross State product figures issued annually by the Federal Reserve Bank of

Table 1.—Mineral production in Connecticut[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ____ thousand short tons	130	$427	95	$250
Lime ____ do	24	1,103	29	1,412
Sand and gravel (construction) ____ do	6,414	12,978	8,543	18,316
Stone ____ do	6,016	17,598	6,989	20,559
Combined value of feldspar, gem stones, mica (scrap), and sand and gravel (industrial)	XX	2,212	XX	3,171
Total	XX	34,318	XX	43,708
Total 1967 constant dollars	XX	17,615	XX	^{p}21,574

^{p} Preliminary. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Connecticut, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Fairfield	$1,447	$4,197	Sand and gravel.
Hartford	W	W	Stone, sand and gravel, clays.
Litchfield	5,539	5,945	Sand and gravel, stone, lime.
Middlesex	3,526	3,362	Feldspar, sand and gravel, stone, mica, clays.
New Haven	W	14,354	Stone, sand and gravel.
New London	W	W	Sand and gravel, stone.
Tolland	W	W	Do.
Windham	W	2,061	Stone, sand and gravel.
Undistributed[1]	23,807	13,790	
Total[2]	34,318	43,708	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes gem stones and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Connecticut business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	1,465	1,502	+2.5
Unemployment do.	138	106	-23.2
Employment (nonagricultural):			
Mining do.	(1)	(1)	--
Manufacturing do.	397.0	404.9	+2.0
Contract construction do.	[2]40.5	[2]42.4	+4.7
Transportation and public utilities do.	52.9	55.4	+4.7
Wholesale and retail trade do.	256.2	268.7	+4.9
Finance, insurance, real estate do.	87.7	90.5	+3.2
Services do.	230.4	242.7	+5.3
Government do.	175.1	178.1	+1.7
Total nonagricultural employment do.	1,239.8	1,282.7	+3.5
Personal income:			
Total millions	$22,687	$25,055	+10.4
Per capita	$7,313	$8,061	+10.2
Construction activity:			
Number of private and public residential units authorized	13,870	15,707	+13.2
Value of nonresidential construction millions	$191.6	$281.9	+47.1
Value of State road contract awards do.	$39.1	$128.0	+227.4
Shipments of portland and masonry cement to and within the State thousand short tons	582	661	+13.6
Mineral production value:			
Total crude mineral value millions	$34.3	$43.7	+27.4
Value per capita, resident population	$11	$14	+27.3
Value per square mile	$6,851	$8,726	+27.4

[p] Preliminary.

[1] Included with "Contract construction."

[2] Includes mining.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the Connecticut mineral industry in 1977[1]

	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate	Nondisabling injuries	Nondisabling injury frequency rate
Sand and gravel:								
Surface	645	850,720	--	--	9	10.58	1	1.18
Office	112	145,599	--	--	--	--	--	--
Total	757	996,319	--	--	9	9.03	1	1.00
Stone:								
Surface	375	801,671	--	--	4	4.99	6	7.48
Mills	79	178,131	--	--	1	5.61	--	--
Office	43	87,096	--	--	--	--	--	--
Total	497	1,066,898	--	--	5	4.69	6	5.62
Clays:								
Surface	7	10,790	--	--	--	--	--	--
Mills	15	23,249	--	--	--	--	--	--
Office	2	4,680	--	--	--	--	--	--
Total	24	38,719	--	--	--	--	--	--
Feldspar:								
Surface	13	30,374	--	--	--	--	--	--
Mills	29	67,941	--	--	--	--	--	--
Office	5	12,049	--	--	--	--	--	--
Total	47	110,364	--	--	--	--	--	--
State total:								
Surface	1,040	1,693,555	--	--	13	7.68	7	4.13
Mills	123	269,321	--	--	1	3.71	--	--
Office	162	249,424	--	--	--	--	--	--
Grand total	1,325	2,212,300	--	--	14	6.33	7	3.16

[1]Data supplied by Mine Safety and Health Administration, U.S. Department of Labor.

Boston. While indigenous mining itself represents only 0.2% of the gross State product, construction (largely dependent upon mineral materials) is 3.5%, and manufacturing is more than 31%. The latter sector of the economy includes manufacture of stone, clay, glass, and primary and fabricated metals (23% of manufacturing); machinery, electrical and electronic components, motor vehicles, and transport (43% of manufacturing); and plastics or rubber (4% of manufacturing). All of these manufacturing categories are dependent entirely, or in part, on mineral-derived products.

Of Connecticut's 1 million industrial workers, only about 1,300 are directly employed in mining, but 40,000 more are employed in construction; and of the 405,000 manufacturing employees in the State, stone, clays, glass, primary metals, and fabricated metal products account for more than 75,000 workers. Other manufacturers heavily dependent upon mineral-derived products as raw materials employ an additional 200,000 persons.

Minerals and mineral products are also important to the rail and truck transport industry of Connecticut. No breakdown of total freight figures were available, but crushed stone is probably the largest single freight item of origin by weight in Connecticut. It moves not only instate, but also to Metropolitan New York and New Jersey by rail and water and it is used for rail roadbed ballast in many parts of the northeast. Silica, lime, feldspar, mica, and dimension stone all enter interstate commerce wholly or in part. Sand and gravel shipments also supply part of Metropolitan New York's needs. Minerals, mineral-derived products, metal scrap, and mineral fuels were the bulk of Connecticut waterborne commerce. Such cargoes were 100% of the freight handled at Thames River, Housatonic River, and Stamford; 99% of the cargo at Norwalk and Connecticut River; 98% at New Haven and Bridgeport; and 93% at New London.

The State Geological and Natural History Survey published a report on the Bedrock Geology of the Norwalk North and Norwalk South Quadrangles. Under its cooperative program with the U.S. Geological Survey, a map on the surficial geology of the Glastonbury Quadrangle was issued.

Construction was underway on the $53 million Connecticut Resource Recovery Authority (CRRA) plant at Bridgeport. It will recover glass, metals, and powdered fuel from 2,000 tons of trash each day, probably starting in 1978. The powdered fuel will be used in conjunction with oil to generate electricity at the Bridgeport Harbor Station of United Illuminating Co.

The most important environmental control-land use legislation being prepared in 1977 involved coastal land management. The State Legislature was considering expanding existing legislation, while a detailed management plan was prepared for submission to the U.S. Department of Commerce; impacts upon future coastal mineral operations and mineral trade are probable but cannot be quantitatively assessed.

Sand and gravel and crushed stone are particularly important mineral products. Increasing urbanization of land areas containing these resources poses a major threat to supplies in the future. In some cases land actually overlying the resources is developed; in other cases land near reserves or near active mines is developed. Mining and holding reserve areas as open land are becoming increasingly difficult. A coordinated effort of local and State governments may be necessary to insure that mining of these materials can continue and that major mineral resource reserves are not preempted by surface land development or by unduly restrictive zoning or legislative practice.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—There are no cement manufacturing plants in Connecticut. Data is not published on origin of cement shipments into the State, but the Hudson River Valley plant would seem to be a logical source. Data on domestic cement shipments received in Connecticut indicate a 14% increase in consumption of cement from 582,000 tons in 1976 to 661,000 in 1977.

Clays.—Common clay was mined by two companies in Hartford and Middlesex Counties. Most of the clay was consumed in the manufacture of building bricks; the rest was utilized by the ceramic and specialty clay products industry.

Feldspar.—The Feldspar Corp. mined feldspar from pegmatites at the Middletown and Hale mines and ground and concentrated it at the Middletown plant in Middlesex County. The ground feldspar was shipped to various States and Canada for use in manufacturing glass and ceramic products. The Middletown operation is the largest feldspar producer in New England.

The solution to one mining-environmental problem was arrived at by The Feldspar Corp. voluntarily agreeing to cleanup River Road in Middletown after the city received complaints about road conditions near the plant entrance. Water carrying feldspar dust had been running onto River Road causing icing in winter and slippery mud on the pavement at other times. Proper guttering and drainage should alleviate the problem.

Gem Stones.—Individuals, mineralogical clubs, and dealers collected specimens and bulk cutting and polishing material from mine dumps, quarries, and pegmatites throughout the State, with most intense interest in the Middletown-Portland old beryl-mica district. Howard Hewitt began rehabilitation of an old mine in the Merryall district for production of gem beryl. Garnet was named the official State mineral. Collecting continues in the Roxbury area where the world's finest gem garnets were once mined.

Lime.—At Canaan, Litchfield County, lime was produced by Pfizer, Inc. The product was sold for sewage treatment, mason's lime, and other uses. Production increased in quantity and value from that of the previous year. The lime was consumed in New England and other States.

Mica.—Sheet, scrap, and flake mica were byproducts of feldspar mining and processing in Middlesex County.

Salt.—The Connecticut Bureau of Highways continued to reduce its use of salt for ice control on State highways and roads. Despite an extremely severe winter, only 79,000 tons was used in 1976-77, compared with the alltime high of 160,000 tons in 1969-70 and 84,000 tons in 1975-76.

Sand and Gravel.—Sand and gravel was exceeded only by stone in value among the mineral products excavated in Connecticut. Production of sand and gravel was reported in all eight counties in the State, led by Hartford and New Haven.

Of the 8.5 million tons of construction sand and gravel produced, 85% was reported sold or used commercially and the rest in publicly funded projects. The production, 33% greater than for 1976 in quantity, was used primarily as an aggregate in either portland cement or bituminous concrete. Other uses were fill, railroad ballast, and foundry sand.

Table 5.—Connecticut: Construction sand and gravel sold or used, by use

(Thousand short tons and thousand dollars)

Use	1976			1977		
	Quantity	Value	Value per ton	Quantity	Value	Value per ton
Construction:						
Sand	3,921	6,877	1.75	3,992	8,508	2.13
Gravel	2,492	6,099	2.45	4,550	9,808	2.16
Total[1]	6,414	12,978	2.02	8,543	18,316	2.14

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Connecticut: Construction sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (nonresidential, residential, highways, bridges, dams, waterworks, airports, etc.)	1,346	3,715	2.76	3,220	8,678	2.69
Concrete products (cement blocks, bricks, pipe, etc.)	925	2,037	2.20	522	1,306	2.50
Asphaltic concrete aggregates and other bituminous mixtures	1,042	2,392	2.30	1,340	2,919	2.18
Roadbase and coverings	1,213	2,182	1.80	1,460	2,598	1.78
Fill	1,654	2,134	1.29	1,393	1,588	1.14
Other uses	234	516	2.21	609	1,226	2.02
Total[1]	6,414	12,978	2.02	8,543	1,832	2.14

[1] Data may not add to totals shown because of independent rounding.

Stone.—Eight companies quarried dimension stone for rubble (48%), rough construction (30%), curbing, rough blocks, dressed construction stone, and other uses. Output was 9,101 tons valued at $239,565. Leading producers were: Castellucci & Sons, Inc., R. V. Olson, and Paul Weiser. Twelve companies crushed stone at 16 quarries for bituminous aggregate, roadstone, concrete, and other uses. Output increased 16% to 6.98 million tons valued at $20.32 million. Leading producers were Ashland Oil, Inc., Balf Co., and Roncari Industries, Inc.

Crushed basalt (including diabase), used chiefly as construction aggregate and railroad ballast, was the major stone product in both volume and value. It was produced in Hartford, Litchfield, and New Haven Counties and constituted an important export from Connecticut. It is barged to New York, New Jersey, and other destinations and carried by rail (for railroad ballast use) as far as Illinois. In tonnage, it constituted the largest rail freight item originating in Connecticut. Among the States, Connecticut ranked fifth in output of crushed traprock.

Crushed limestone and dolomite were produced in Litchfield County by three operators. It was marketed for agricultural limestone, lime manufacturing, stucco, and filler. It also constituted the raw material basis for production of calcium at Canaan.

Crushed sandstone produced in Middlesex County was used in manufacturing fine aggregate for construction, filtration, and terrazzo. Quartz was produced in New London and Middlesex Counties for use in glass, terrazzo, asphalt and other industrial fillers, and as flux stone and abrasives. The quartz from Middlesex County was a byproduct of milling pegmatite ore for feldspar. The New London County quartz was produced from a large quartz replacement body at Lantern Hill. Dimension sandstone was produced in Windham County and sold for rubble and rough construction.

Dimension granite was produced in Hartford, New Haven, New London, Tolland, and Windham Counties. It was sold as building stone veneer, rough blocks, rubble, flagging, curbing, ashlar, and irregular stone.

The Lantern Hill Valley Citizens Association complained to the North Stonington Planning and Zoning Commission about noise from the Ottawa Silica Co. mine at Lantern Hill. The residents were seeking to have night mining and crushing halted but the commission said it lacked the authority to regulate a firm's hours of operation.

The Mine Safety and Health Administration and American Mining Congress' annual mining safety awards included one to a Connecticut operation. In the category of open pit stone quarries, the national winner was the North Branford quarry of New Haven Trap Rock/Tomasso, a division of Ashland Oil, Inc., for experiencing 277,777 hours of employee exposure without a disabling injury.

Table 7.—Connecticut: Production of crushed stone,[1] by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Bituminous aggregate	1,782	4,508	2,054	5,568
Roadstone	1,536	4,554	1,836	5,414
Concrete aggregate	1,256	3,177	1,533	4,148
Dense-graded roadbase stone	456	1,304	523	1,536
Surface treatment aggregate	197	616	222	702
Macadam aggregate	35	85	62	201
Agricultural limestone	56	388	W	W
Filter stone	71	216	43	130
Riprap and jetty stone	W	W	38	102
Other uses[2]	616	2,533	670	2,519
Total[3]	6,006	17,380	6,980	20,320

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes traprock, granite, limestone, and sandstone.

[2] Includes stone used for railroad ballast, lime manufacture, glass manufacture, flux stone, stucco, other filler, terrazzo, exposed aggregate (1976), and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

METALS

Ferrous Metals.—There were six steel fabrication mills in the State producing bars, rods, coils, strips, and wire rope from primary shapes. The Abbott Ball Co., Hartford County, produced steel shot and grit. Approximately 75 foundries produced ferrous and nonferrous castings, and 11 foundries produced ferrous and nonferrous forgings and ingots.

About 25 scrap metal dealers collected and processed ferrous metal for export and for sale to area foundries.

Nonferrous Metals.—Pfizer, Inc., at Canaan, Litchfield County, was the only known commercial producer of calcium metal in the United States. Pfizer also was reported to have produced barium metal at Canaan. Fabrication of copper and brass and related products remains a major Connecticut industrial activity although the State share of U.S. production has slipped from 22.4% to 13.3% during the past 10 years while its share of primary brass production dropped from 25.6% to 14.6%.

Bridgeport Brass Co., a division of National Distillers and Chemicals Corp., announced plans to close its Bridgeport brass mill. The plant, which employed 775 workers, was said to be at a competitive disadvantage compared with other company and industry brass mills. The Rolla (Mo.) Metallurgy Research Center of the Bureau of Mines, in efforts to lessen adverse environmental effects from brass operations, successfully regenerated chromium etching wastes from Century Brass Co. of Waterbury. In a one-step treatment the sample was electrolytically oxidized with simultaneous removal of about half the contained copper and zinc. The regenerated solution proved the equal in use of fresh etching solutions, giving the promise of economic as well as ecological benefits.

The U.S. Department of Energy developed plans to test the uranium potential of the Mesozoic age rocks in the Connecticut Valley as part of the National Uranium Resource Evaluation Program (NURE). Preliminary plans called for a series of test borings to be made at or near the sites of old copper and barite mines. Recent changes in funding and in project schedules have halted immediate further work on the project.

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[1] Geologist, State Liaison Officer, Bureau of Mines, Newmarket, N.H.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Kelsey-Ferguson Brick Co (a division of Susquehanna Corp.)	Route 5 East Windsor Hill, CT 06028	Pit	Hartford.
The Michael Kane Brick Co	654 Newfield St. Middletown,CT 06475	Pit	Middlesex.
Feldspar:			
The Feldspar Corp.[1]	Spruce Pine, N.C. 28777	Pits and plant	Do.
Lime:			
Pfizer, Inc.[2]	Daisy Hill Rd. Canaan, CT 06018	Pit and plant	Litchfield.
Sand and gravel:			
Dunning Sand & Gravel Co., Inc	Brickyard Rd. Farmington, CT 06037	Pit	Hartford.
Leverty & Hurley	260 Bostwick Ave. Bridgeport, CT 06605	Pit	New Haven.
Loma Sand & Gravel Co	Box 277 Newton, CT 06470	Pit	Fairfield.
Miller Bros	Box 100 South Windham, CT 06266	Pit	Windham.
Roncari Industries, Inc.[3]	1776 South Main St. East Granby, CT 06026	Pit	Hartford.
Sega Sand & Gravel Co. Inc	271 Danbury Ave. New Millford, CT 06776	Pit	Litchfield.
Windham Sand & Stone, Inc	Box 346 Willimantic, CT 06026	Pit	Windham.
Silliman Co	290 North Ave. Bridgeport, CT 06601	Pit	New Haven.
Silica, ground and crushed:			
Ottawa Silica Co	Box 577 Ottawa, IL 61350	Pit and plant	New London.
Stone:			
Basalt, crushed and broken:			
Balf Co.[4]	Box 11190 Newington, CT 06111	Quarry	Hartford.
New Haven Traprock/ Tomasso (a division of Ashland Oil Inc.)[5]	Box 5033 Hamden, CT 06518	Quarries	Hartford and New Haven.
Oneglia and Gervasini Building Materials.	Box 907 Torrington, CT 06790	Quarry	Litchfield.
York Hill Trap Rock Quarry Co.	Westfield Rd. Meriden, CT 06450	do	New Haven.

[1] Also crude mica, ground and crushed silica.
[2] Also limestone and dolomite.
[3] Also basalt.
[4] Also sand and gravel.
[5] Also crushed granite.

The Mineral Industry of Delaware

This chapter has been prepared under a Memorandum of understanding between the Bureau of Mines, U.S. Department of the Interior, and the Delaware Geological Survey for collecting information on all minerals in the state.

By Joseph A. Sutton[1] and Marilyn N. Dimmitt[2]

The value of mineral production in 1977 in Delaware rebounded from the previous year's loss by reaching almost $2.1 million, 14% above the 1976 figure.

As in previous years, Delaware's chief mineral commodity was sand and gravel. In 1977, 1.4 million tons was produced at a value of $2.1 million, a tonnage increase of 21% compared with 1976 output. The increase was mainly due to an overall increase in construction activity requiring concrete. The mining of common clay for use in producing building brick continued to be comparatively small with only one producer in the State. Gypsum, gem stones, and magnesium compounds were other mineral-related activities carried on in Delaware.

Employment.—Final 1977 statistics and preliminary data for 1977 on business activity of the State are given in Table 2.

Legislation and Government Programs.—Governor du Pont signed into law Senate Bill 300 which requires oil-carrying vessels in Delaware waters to carry up to $30 million in insurance, and owners of oil pipeline docks and tanks to carry insurance up to $50 million against oil spills. The new law makes it possible for businesses with probable losses related to spills to collect damages and provides for a speedier cleanup of oil spills.

Delaware has been developing a Coastal Management Program under the auspices of the Federal Coastal Zone Management Act of 1972. The program is to provide a systematic approach to decisionmaking regarding the use of Delaware's coastal lands and waters in a manner that provides reasonable use while conserving the irreplaceable resources of Delaware's coastal zone. A draft program document of Delaware's Coastal Management Program was completed in 1977.

Table 1.—Mineral production in Delaware[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---- thousand short tons	11	$8	11	$7
Sand and gravel ---- do	1,117	1,829	1,351	2,084
Total	XX	[2]1,837	XX	[2]2,091
Total 1967 constant dollars	XX	943	XX	[p]1,032

[p] Preliminary. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Partial total; excludes the value of gem stones and magnesium compounds, which must be concealed to avoid disclosing individual company proprietary data.

The Department of Energy (DOE) plans to assess the status of geothermal energy in deep drilled holes in the Atlantic Coastal Plain. The drilled holes are to be sited and logged for measuring the geothermal gradient of the Coastal Plain, and a gravimetric survey is to be made to study the crystalline basement. The Delaware Geological Survey has applied for a grant from DOE and expects to participate and coordinate geothermal investigation activities in Delaware. Projected work carried out under the contract will include a gravity survey of portions of Kent and Sussex Counties and precise measurement of temperatures in selected existing deep wells in Delaware.

Work under a grant by the Federal Bureau of Mines to the Delaware Geological Survey for research on Delaware's greensand was completed in July 1977. Results of the research indicated that greensand holds promise for the removal of metallic ions from waste water.

Table 2.—Indicators of Delaware business activity

	1976	1977^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	259.0	270.0	+4.2
Unemployment do	23.0	23.0	--
Employment (nonagricultural):			
Mining do	(1)	(1)	--
Manufacturing do	68.2	67.7	-.7
Contract construction do	14.5	14.2	-2.1
Transportation and public utilities do	11.9	12.2	+2.5
Wholesale and retail trade do	52.3	51.6	-1.3
Finance, insurance, real estate do	11.0	11.0	--
Services do	[2]38.3	[2]38.9	+1.6
Government do	40.2	40.0	-.5
Total nonagricultural employment do	236.4	235.6	-.3
Personal income:			
Total millions	$4,135	$4,477	+8.3
Per capita	$7,107	$7,697	+8.3
Construction activity:			
Number of private and public residential units authorized	2,647	3,414	+29.0
Value of nonresidential construction millions	$29.4	$50.8	+72.8
Value of State road contract awards do	$25.3	$19.8	-21.7
Shipments of portland and masonry cement to and within the State thousand short tons	149	157	+5.4
Mineral production value:			
Total crude mineral value millions	$1.8	$2.1	+13.8
Value per capita, resident population	$3	$4	+33.3
Value per square mile	$893	$1,017	+13.9

^{p}Preliminary.

[1] Included with "Services."

[2] Includes mining.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and Federal Bureau of Mines.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—The Delaware Brick Co. continued to be the only producer of clay in the State. The company reported production of 11,000 tons, a slight decrease compared with that of 1976, the value of clay was $6,561. The clay was mined in New Castle County and used to produce building brick. Ninety percent of the brick produced in 1977 was face brick, and the remainder was common brick.

Gypsum.—Gypsum rock mined in Nova Scotia was shipped to the Georgia-Pacific Corp. plant in New Castle where it was calcined to produce wallboard. Because of the weight of the product, shipping distance from the plant is limited to about 200 miles.

Magnesium Compounds.—The Barcroft Co. plant at Lewes continued to produce magnesium hydroxide from water extracted from the Delaware Bay near the Atlantic Ocean. The plant was built in 1969 and has a reported capacity of 5,000 tons annually. The magnesium is concentrated from seawater by a sodium hydroxide pH control type of precipitation to form magnesium hydroxide and is used for pharmaceutical purposes.

Sand and Gravel.—Delaware's 1977 production of sand and gravel output was up 21% in quantity and 14% in value with a continued demand for unprocessed sand and gravel in the use of roadbase and fill. Other major uses of construction sand and gravel were for residential, nonresidential, highways, bridges, dams, waterworks, airports, etc. Of the sand and gravel produced, 390,000 tons valued at $885,000 was processed, and 961,000 tons valued at $1.2 million was unprocessed. Continued leading producers were Woodlawn Gravel Co. and Parkway Gravel, Inc., both of New Castle County.

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[1] State Liaison Officer—Maryland and Delaware, Bureau of Mines, Washington, D. C.

[2] Program assistant—Maryland and Delaware, Bureau of Mines, Washington, D. C.

Table 3.—Principal producers

Commodity and company	Address	Type of activity	County
Clays: Delaware Brick Co	River Rd. New Castle, Del. 19720	Pit	New Castle.
Gypsum, calcined: Georgia-Pacific Corp	900 SW 5th Ave. Portland, Oreg. 97204	Plant	Do.
Magnesium compounds: Barcroft Co	Box 474, Henlopen Dr. Lewes, Del. 19958	do	Sussex.
Sand and gravel:			
Barber Sand and Gravel	R.F.D. 1 Harrington, Del. 19952	2 dredges	Kent.
Clough & Caulk Sand & Gravel	Route 1, Box 129 Wyoming, Del. 19934	Pit	Do.
Contractor Sand & Gravel Co	Box 2630 Wilmington, Del. 19805	2 pits	New Castle.
Delaware Sand & Gravel Co	R.D. 2, Box 286 New Castle, Del. 19720	Pit	Do.
Dover Equipment & Machine Co	113 East 6th St. Dover, Del. 19901	2 dredges	Kent.
George Nashold, Inc	Box 286 Frederica, Del. 19946	3 dredges	Do.
Parkway Gravel, Inc	4048 New Castle Ave. New Castle, Del. 19720	4 pits	New Castle.
Staytons Select Borrew Pit	R.D. 1, Box 305 Felton, Del. 19943	Pit	Kent.
Warren Bros. Tarburton Pit	Box 858 Dover, Del. 19901	2 dredges	Do.
Whittington's Sand & Gravel Co	U.S. Route 40 Bear, Del. 19701	Pit	New Castle.

The Mineral Industry of Florida

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Florida Bureau of Geology.

By John W. Sweeney[1] and Charles W. Hendry, Jr.[2]

The value of mineral production for 1977 remained at the same level as in 1976, $1.6 billion, indicating a stabilizing trend following the decrease recorded from 1975 to 1976.

Of the 47.3 million metric tons of phosphate rock produced in the United States, Florida and North Carolina produced 40.6 million metric tons. Of this total, Florida was the predominant producer and, for the 84th consecutive year, supplied more than any other State. The State ranked first in the Nation in the value of phosphate rock, second in the value of fuller's earth, rare-earth concentrates, and titanium minerals, and eighth in the value of stone. Staurolite was produced only in Florida. Florida and North Carolina supplied 86% of the domestic phosphate rock output, and Florida supplied most of the exports. Phosphate rock was exported from the ports of Tampa, Boca Grande, and Jacksonville. The principal recipients were the Federal Republic of Germany, Canada, and Japan.

Table 1.—Mineral production in Florida[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland thousand short tons	1,949	$67,832	2,540	$87,561
Clays do	680	20,672	581	[2]22,313
Lime do	179	7,798	165	7,350
Natural gas million cubic feet	43,165	42,388	48,171	52,458
Peat thousand short tons	79	1,287	125	1,396
Petroleum, crude thousand 42-gallon barrels	44,460	499,573	46,641	544,254
Sand and gravel thousand short tons	13,204	19,164	20,218	38,989
Stone[3] do	38,606	74,412	48,558	101,435
Combined value of cement (masonry), clays (kaolin, 1977), magnesium compounds, natural gas liquids, phosphate rock, rare-earth concentrates, staurolite, stone (dimension), titanium concentrates (ilmenite and rutile), and zirconium concentrates	XX	919,106	XX	762,801
Total	XX	1,652,232	XX	1,618,557
Total 1967 constant dollars	XX	848,091	XX	[p]798,920

[p]Preliminary. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes value of kaolin; value included in "Combined value" figure.

[3] Excludes dimension stone; value included in "Combined value" figure.

Table 2.—Value of mineral production in Florida, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Alachua	$1,629	$2,278	Stone.
Bay	470	509	Sand and gravel.
Bradford	W	--	
Brevard	1,321	2,600	Sand and gravel, stone.
Broward	8,711	10,728	Stone, sand and gravel.
Calhoun	W	15	Sand and gravel.
Charlotte	W	W	Sand and gravel, stone.
Citrus	2,700	2,172	Stone, phosphate rock.
Clay	31,572	24,378	Zircon, ilmenite, rutile, staurolite, sand and gravel, clays, monazite.
Collier	14,920	2,877	Stone.
Dade	W	W	Cement, stone, sand and gravel.
Dixie	W	W	Stone.
Escambia	86,031	466	Sand and gravel.
Gadsden	W	W	Clays, sand and gravel.
Glades	W	W	Sand and gravel.
Gulf	W	W	Magnesium compounds, lime.
Hamilton	W	W	Phosphate rock.
Hendry	35,555	W	Sand and gravel, stone.
Hernando	W	W	Stone, cement, lime, clays.
Highlands	356	678	Peat.
Hillsborough	W	W	Cement, phosphate rock, stone, peat, sand and gravel.
Jackson	W	520	Stone, sand and gravel.
Lake	2,273	4,560	Sand and gravel.
Lee	13,267	5,435	Stone.
Leon	W	W	Sand and gravel.
Levy	877	1,905	Stone.
Manatee	W	W	Cement, stone.
Marion	6,532	8,204	Stone, clays, sand and gravel, phosphate rock.
Monroe	W	333	Stone.
Nassau	W	W	Titanium, zircon, monazite.
Okaloosa	W	24	Sand and gravel.
Orange	W	--	
Osceola	144	16	Stone.
Palm Beach	120	W	Sand and gravel, stone.
Pasco	999	1,358	Stone.
Polk	W	W	Phosphate rock, sand and gravel, stone, peat.
Putnam	W	W	Sand and gravel, clays, peat.
St. Lucie	295	W	Sand and gravel.
Santa Rosa	450,831	W	Do.
Sarasota	1,327	W	Sand and gravel, stone.
Sumter	W	W	Stone, lime, peat.
Suwannee	W	W	Stone.
Taylor	W	W	Do.
Wakulla	W	W	Sand and gravel.
Walton	W	W	Do.
Undistributed[2]	992,306	1,549,509	
Total[3]	1,652,232	1,618,557	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Baker, Columbia, De Soto, Duval, Flagler, Franklin, Gilchrist, Hardee, Holmes, Indian River, Jefferson, Lafayette, Liberty, Madison, Martin, Okeechobee, St. Johns, Pinellas, Seminole, Union, Volusia, and Washington.

[2] Includes petroleum, natural gas, and natural gas liquids that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Florida business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force — thousands	3,446.0	3,520.0	+2.1
Unemployment — do.	311.0	289.0	-7.1
Employment (nonagricultural):			
Mining — do.	8.8	8.8	--
Manufacturing — do.	354.0	374.6	+5.8
Contract construction — do.	166.7	172.4	+3.4
Transportation and public utilities — do.	181.4	184.1	+1.5
Wholesale and retail trade — do.	730.8	751.9	+2.9
Finance, insurance, real estate — do.	191.3	199.1	+4.1
Services — do.	608.5	627.0	+3.0
Government — do.	542.8	555.0	+2.2
Total nonagricultural employment — do.	2,784.3	2,872.9	+3.2
Personal income:			
Total — millions	$50,993	$56,496	+10.8
Per capita	$6,105	$6,684	+9.5
Construction activity:			
Number of private and public residential units authorized	66,691	108,052	+62.0
Value of nonresidential construction — millions	$879.5	$1,070.0	+21.7
Value of State road contract awards — do.	$268.7	$280.0	+4.2
Shipments of portland and masonry cement to and within the State — thousand short tons	3,569	4,114	+15.3
Mineral production value:			
Total crude mineral value — millions	$1,652.2	$1,618.6	-2.0
Value per capita, resident population	$196	$191	-2.6
Value per square mile	$28,214	$27,639	-2.0

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

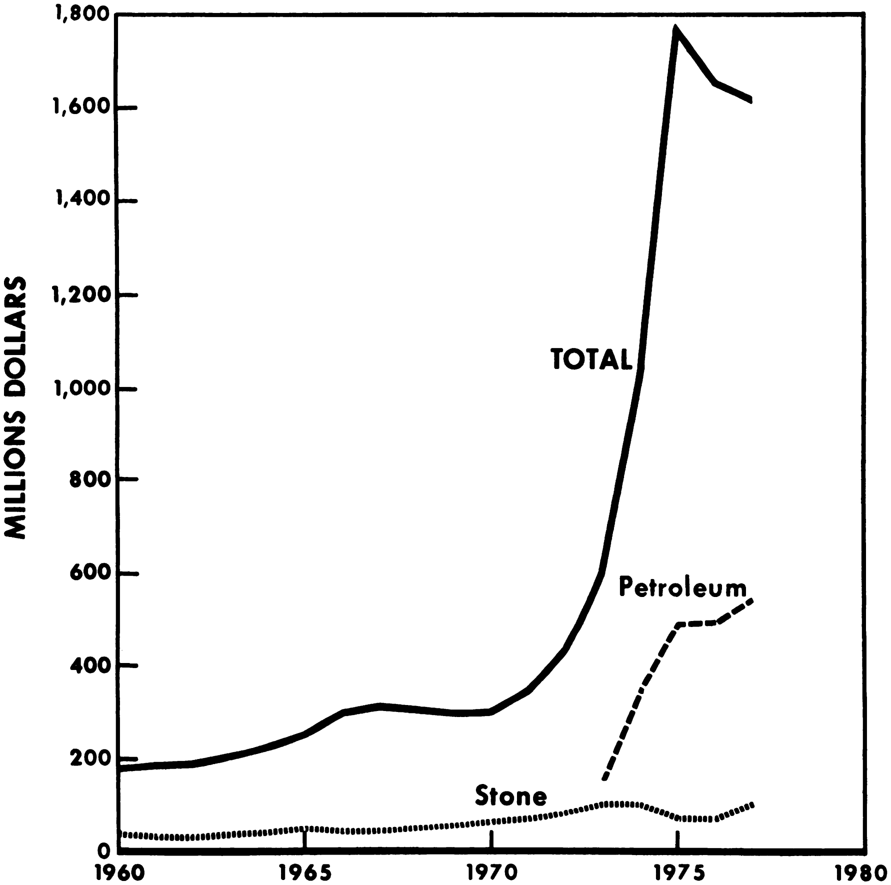

Figure 1.—Value of stone, petroleum, and total value of mineral production in Florida.

During the year, several companies announced plans to recover uranium from wet-process phosphoric acid and to build facilities. Prior to these announcements, only Uranium Recovery Corp. had constructed a uranium concentrating facility at Mulberry with a recovery module at W. R. Grace & Co.'s Bonny Lake facility. To date, no commercial shipments have been recorded.

International Minerals & Chemicals Corp. (IMC) has applied for State permits to build a uranium recovery facility at its New Wales chemical plant in Polk County. The company announced that it plans to recover 625,000 pounds of uranium (U_3O_8) annually with the plant going onstream in 1980.

Wyoming Minerals Corp., a subsidiary of Westinghouse Electric Corp., is constructing a uranium recovery facility at Farmland Industries' phosphoric acid complex near Bartow. Plans are to recover about 450,000 pounds of U_3O_8 with the plant going onstream in 1978.

Gardinier, Inc., announced plans to build its own uranium recovery plant at its East Tampa operations. The $15 million plant will produce 425,000 pounds of uranium annually.

In addition, Freeport Chemical Co. ships phosphate rock to its phosphoric acid facility in Louisiana where it expects to recover 690,000 pounds of uranium annually.

Joyce Western Corp. has proposed to build an anhydrous ammonia pipeline from the Port of Tampa to the central Florida phosphate area, 70 miles inland. The estimated cost of the 6-inch buried pipeline would be $5 million. The corporation has an initial agreement with the Royster Co. for the line to serve Royster's Mulberry facility. The Tampa Port Authority has agreed to consider assistance.[3]

Seminole Electric Cooperative announced plans to build a $600 million, coal-fired generating plant outside Palatka in Putnam County. The plant calls for construction of a 600-megawatt plant costing $600 million, scheduled for operation in 1983. While the first unit is being built, plans call for construction of a second 600-megawatt unit at the same site at roughly the same cost (plus inflation) to go online in 1985.[4]

The amount of cargo moving through Tampa's port increased 12.7% during the first 6 months of the year indicating one of the biggest growth years in the port's history. A total of 23.3 million tons of cargo moved through the port between the beginning of January and the end of June. About 80% of the increase was in the movement of bulk commodities, especially phosphate and liquid sulfur. There has been a recent trend toward shipping phosphoric acid rather than fertilizer to foreign and domestic markets.[5]

Tonnage moving through the Port of Jacksonville is expected to increase 8% due to Occidental Chemical Co.'s trade agreement with the Soviet Union. Under the agreement, Occidental will be shipping 1 million tons of superphosphoric acid annually by 1980 for a 20-year period.[6]

The Florida economy in 1977 grew at a moderate to strong pace, highlighted by strong gains in several kinds of employment especially contract construction. Florida had a growth economy, as indicated by population gains, of around 2.0% in 1977. This rebound in population growth remains the primary stimulus to Florida's growth for 1978 and 1979. The population growth can be equated with accelerated housing starts and increased output of construction raw materials. Diversified industrial expansion was not yet a major determinant of Florida's long-term economic growth.[7]

Legislation and Government Programs.—Texas Instruments, Inc., continued preparation of an Environmental Impact Statement (EIS) sponsored by the Environmental Protection Agency (EPA). The draft EIS is expected to provide environmental, economic, and social analyses of the potential impacts on the Florida phosphate region by the mining of phosphate. The draft EIS is scheduled to be completed in early 1978, with public hearings to follow prior to completion of the final EIS. No formal moratorium was called pending the EIS preparation, but no new EPA permits have been issued in the area since the studies began. All existing phosphate mining and processing operations were continued.

EPA continued its program of assessing elevated radiation levels in Florida's phosphate-producing areas and released its third report on the subject, "Effects of Phosphate Mineralization and the Phosphate Industry on Radium-226 in Ground Water of Central Florida." The report generally concluded that phosphate mining in central Florida has not contributed to increased radium-226 levels in the Floridian aquifer.[8]

An interim report (January 1977) by the Florida Department of Health and Rehabilitative Services on radiation levels in reclaimed phosphate land in Polk County indicates no serious health risks exist but does confirm results of the first EPA study, which found a small percentage of the reclaimed areas having radiation levels exceeding those set by the U.S. Surgeon General. The State study sampled 1,000 homes, compared with 125 in the EPA study.[9]

The Florida Department of Environmental Regulation funded a survey to determine the magnitude of the hazardous-waste problem in Florida in order to establish a hazardous-waste management program.[10]

The Florida Department of Environmental Regulation imposed new standards on phosphate mine discharges into the State's waters. The standards are considerably stricter than those set by EPA; they set limits on suspended solids, pH, and phosphorus.

The Federal Bureau of Mines assisted the U.S. Geological Survey in conducting a study in the Osceola National Forest in north Florida to determine and analyze the effects that proposed phosphate mining in the forest would have on the area's water and wildlife. The Secretary of the Interior called for the study to obtain additional necessary information so that proper decisions could be made on awarding preferential right leases to the 41 applications to develop the phosphate deposits in the national forest.

The U.S. Fish and Wildlife Service proposes a systematic study of all U.S. domestic phosphate reserves, including a national economic study on phosphate and a long-term sequential mining program (Fish and Wildlife Status Report, 13 April 1977). The object of the program is to identify ways to provide the needed phosphate over a period of time while minimizing the impacts upon fish and wildlife resources.

U.S. Representative Don Fuqua submitted a bill to Congress entitled "A bill to terminate any phosphate leases issued pursuant to the Mineral Leasing Act of February 25, 1920, as amended, and rights to such leases within the Osceola National Forest to direct the Secretary of the Interior to take action with respect to the same."

The Argonne National Laboratory, under contract to the U.S. Geological Survey's Resource and Land Investigations (RALI) Program, conducted a series of case studies to familiarize professional land-use and resource planners with the range of possibilities and planning procedures for achieving integrated mining, reclamation, and land-use planning.[11]

The Coastal Zone Management Act (Section 307) calls for interagency coordination and cooperation between the U.S. Department of Commerce and other interested Federal agencies. Title 15, Code of Federal Regulations 923.15, specifies that participating States must consult with the Bureau of Mines, as a cognizant Federal agency, concerning national interest questions on mineral resources. The Bureau of Mines has reviewed Florida's Coastal Zone Management Public Hearing Draft and submitted review comments suggesting that, in developing a comprehensive program, the following items with respect to mineral resources, should be addressed:

1. What are the mineral resources and/or reserves in the program area?
2. Identify mineral-processing plants in the program area.
3. What are the future mineral requirements needs of the program area?
4. What is the future mineral resource development potential, and what is its impact in the program area?
5. What are permissible mineral resource and/or mineral-processing uses in the program area?

Recognizing the need to maintain a high standard of environmental quality and the need to solve an ever-increasing waste disposal problem, the Bureau of Mines and the Florida phosphate mining industry joined in a cooperative effort to conduct the research necessary to develop economic processing methods that will either eliminate the slimes retention areas or provide a waste storage system that will not pose a potential threat to the environment. The program was extended through 1977. To further complement this cooperative research effort, the Bureau of Mines let several grants to two State universities to provide additional basic research data. Inhouse Bureau of Mines project activity during 1977, conducted at its own research facilities, included research on the effect of reagents on dewatering slimes; physical and chemical characteristics in flocculation behavior; recovering, utilizing, and purifying industrial waste waters; radiation hazards from reclaimed phosphate land; and recovering phosphate from Florida processing slimes.

Additional Bureau of Mines research programs that are not related to slimes dewatering are beneficiation of the Hawthorn Formation for recovery of phosphorite, direct acidulation of phosphate matrix to improve recovery of P_2O_5, and manufacture of glastile from waste glass and waste clay to be installed in the new Florida capitol complex.

An evaluation of phosphate reserves in Florida will be made under the Bureau of Mines Minerals Availability System. A 12-month, $182,000 study was awarded to a consulting firm to collect widely scattered geologic, economic, environmental, and mining information that will help form the basis for estimating the ultimate "reserve life" of Florida's phosphate deposits. The reserve and resource data obtained in this study will be used as base data in the EPA-sponsored EIS.

A report on "Water Recirculation System Balance of Central Florida Phosphate Mining" was completed under Federal Bureau of Mines contract in an effort to achieve a better understanding of the total use of water in phosphate mining activity.

The Florida Legislature amended Chapter 211, Part II, of the Florida Statutes, increasing the severance tax on land pebble phosphate from 5% to 10%. The proceeds from the tax imposed, excluding the amount credited for ad valorem tax payments, shall be paid into the State Treasury as follows: 75% to the credit of the General Revenue Fund and 25% to the credit of the Land Reclamation Trust Fund established for refunds under the provisions of Section 211.32(3), Florida Statutes.

The Statute also created the Phosphate Land Reclamation Study Commission, charging the Commission to make a study of land disturbed by the severance of pebble phosphate rock for purposes of reclamation. The study was to include an inventory of lands disturbed by the severance of phosphate rock prior to July 1, 1975, which have not been reclaimed. The inventory was to consider both the surface and subsurface ownership. Estimates of the present and future costs of reclaiming these lands are also required.

The Tampa Bay Regional Planning Council recommended that the Governor and the State legislature budget $4 million to assist municipalities and counties required by law to make plans for resource recovery facilities. Resource recovery was mandated by the Resource Recovery Act of 1974 and called for municipalities and counties to develop resource recovery programs by July 1978. County officials throughout the State have pointed out that, if they must abide by the law, but without receiving financial assistance from the State, they cannot comply.

In addition to conducting its normal geological activities, the Florida Bureau of Geology was involved with the Federal Bureau of Mines in the following areas:

1. The Florida Bureau of Geology obtained a 50-foot core sample from an area in Polk County emitting high background radiation levels. The core was characterized at the Federal Bureau of Mines, Tuscaloosa (Ala.) Metallurgy Research Center to determine the source of the radiation. A split of the core was furnished to EPA for additional radiological examinations. These studies were scheduled to be completed in 1978.

2. The Federal Bureau of Mines awarded a grant to the Florida Bureau of Geology to inventory and categorize mined central Florida phosphate lands for purposes of determining the relationship between mined lands, reclaimed lands, waste disposal areas, and elevated radiation levels attributed to these areas. The study was to be correlated with an ongoing EPA program studying radiation levels in structures built on "reclaimed" phosphate lands. The results of this study were expected in early 1978.

3. The Federal Bureau of Mines has two cooperative agreements with the Florida Bureau of Geology. One entails the collection of statistical data and the other is to conduct field and laboratory examinations, economic studies, etc., on the State's mineral resources.

The Big Cypress Swamp Advisory Committee, a five-member environmental advisory group established by the Executive Board of the Florida Department of Natural Resources during 1977, has conducted onsite inspections of 26 proposed drilling sites in the environmentally sensitive area of southwest Florida. These inspections have insured the continued protection of the Big Cypress Swamp area during the exploration for and production of hydrocarbons by adjusting the surface location of the drilling sites to avoid undue impact on the biology and hydrology of the area. This area contains over one-half of the producing oil and/or gas wells in Florida.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for 58% of the State's total mineral production value in 1977. The principal nonmetals produced, listed in order of value, were phosphate rock, stone, cement, sand and gravel, and clays.

Cement.—Shipments of both portland and masonry cement increased substantially over those of 1976, indicating an upswing in the State's construction activity. Portland cement shipments and value were 2.5 million short tons and $88 million, respectively. The value of portland cement increased 29% over that of 1976.

Types I and II (general-use and moderate-heat), Type III (high-early-strength), white cement, and waterproofed portland cements were produced. Most of the shipments were made within the State. Masonry shipments were principally within the State.

Portland cement shipments, mainly in bulk form, were made 17% by truck and 83% by rail. The consumption pattern of portland cement in the State was 55% to ready-mix concrete companies, 12% to building materials dealers, 16% to concrete products manufacturers, 8% to highway contractors, and 9% for miscellaneous applications.

Raw materials used in the manufacture of cement were mined principally within the State and included limestone, clay, sand, and staurolite. Oolitic aragonite imported from the Bahamas was used exclusively by one company, while another firm used minor amounts of the aragonite. Minor amounts of blast furnace slag, iron ore, clay, fly ash, and gypsum were used, but most were obtained from out-of-State sources. Eleven rotary kilns were operated at five plants. Of the five plants, four used the wet process and one used the dry process. Over 339 million kilowatt-hours of energy was consumed in the manufacture of cement; 100% of the power was purchased.

Lone Star Industries, Inc., announced it had created a new subsidiary, Lone Star Florida, Inc., which made an offer to purchase the principal operating assets of Maule Industries, Inc. of Miami.[12]

Clays.—Total clay output decreased 15% while the value increased 14%. Florida ranked first in the Nation in output of fuller's earth.

Fuller's earth production increased 5% in output and 16% in value, reflecting a significant increase in unit value. Three producers were active — two in Gadsden County and one in Marion County. Fuller's earth was used for fillers, oil and gas absorbents, pet absorbents, pesticides, drilling mud, paper coating, and other uses.

Kaolin output increased 11% and its value 18% over that of 1976. Kaolin was produced by one company in Putnam County; principal uses were in white ware, pottery, and wall tile.

Miscellaneous clay output decreased 51%, and the value decreased 59% from that of 1976, reflecting the diminished use for the manufacture of cement.

The clays were used in the manufacture of cement and lightweight aggregate. Mines were operated in Clay and Hernando Counties.

Fluorine.—Fluorine in the form of fluosilicic acid was recovered from six plants as a byproduct of wet-process phosphoric acid manufacture. Fluosilicic acid was used to produce cryolite, aluminum fluoride, and sodium silico-fluoride and for water fluoridation. The value of fluorine byproducts is not included in the State's mineral production value.

Gypsum.—Crude gypsum was imported from mines in Nova Scotia, Canada, and Jamaica and processed into gypsum building products at two plants in Duval County and one plant in Hillsborough County. United States Gypsum Co., Jim Walter Corp., and National Gypsum Co. calcined crude gypsum in kettles, a rotary kiln, and a Holoflite unit. A total of 571,000 short tons of calcined gypsum was produced, a 51% increase over that of 1976, which reflects a strong recovery in the State's construction activity. Byproduct phosphogypsum from phosphate fertilizer manufacture was sold by several of the chemical fertilizer companies.

Lime.—Quicklime was produced by Basic Magnesia, Inc., Gulf County; Chemical Lime, Inc., Hernando County; and Dixie Lime & Stone Co., Sumter County. Hydrated lime was produced by Chemical Lime, Inc., and Dixie Lime & Stone Co. The total sold or used was 165,000 short tons valued at $7.3 million. Compared with those of 1976, quantity and value decreased 8% and 6%, respectively. The lime was used in the pulp and paper industries, in the recovery of magnesia from seawater, in construction, in waste neutralization, in water treatment, and in other chemical processes.

Magnesia.—Basic Magnesia, Inc., Port St. Joe, Gulf County, produced caustic calcined magnesia from refractory-grade magnesia from seawater. Shipments increased 4% and the value increased 11% over those of 1976.

Peat.—Peat production increased from 82,700 short tons in 1976 to 145,000 short tons in 1977, a 75% increase in output. Sales increased from 78,800 short tons in 1976 to 125,000 short tons in 1977, while the value increased from $1,287,000 to $1,396,000, representing a 59% increase in sales and an 8% increase in value. Eight companies produced moss, reed-sedge, and humus peat from five counties. Shipments totaled 125,000 short tons and consisted of 49% moss, 20% reed-sedge, and 31% humus. Most of the peat was shipped in bulk and used to pack flowers, plants, and shrubs; for general soil improvement; and in potting soils.

Perlite.—Four companies produced expanded perlite from ore mined in Colorado and New Mexico. Production increased to 27,000 short tons from 24,000 short tons. The quantity sold or used was 26,000 short tons valued at $2 million, a 40% increase in value over that of 1976. Production from plants in Broward, Duval, Escambia, and Indian River Counties was used for horticultural uses, plaster and concrete aggregate, and formed products.

Phosphate Rock.—Florida's 1977 production data are combined with those of North Carolina to conceal the latter's output because there is only one producing company in North Carolina. Combined marketable production from both States in 1977 increased 8% to 40.5 million metric tons valued at $718 million. The value decreased 17%, reflecting a continuation of price softening that began in late 1975.

The combined States' output represented 86% of the national output. Combined marketable production sold or used totaled 40.9 million metric tons valued at $726.9 million, a 2% increase in sales but a 6% decrease in value from that of 1976.

Most of the 12.7 million metric tons of marketable phosphate rock exported from Florida and North Carolina was from Florida. Florida's exports increased 45% due to a strong foreign demand.

Of that sold or used, agricultural uses accounted for 68%; industrial, 1%; and exports, 31%. Agricultural uses were for wet-process phosphoric acid, normal superphosphate, triple superphosphate, direct application to the soil, and defluorinated phosphate rock for stock and poultry feed. Industrial uses were for the manufacture of elemental phosphorus and ferrophosphorus.

Mine production of crude dry ore in Florida and North Carolina was 155 million metric tons with a P_2O_5 content of 17.9 million metric tons.

Soft-rock phosphate was produced in Florida by four companies operating six mines in two counties. Total mine production was 25,000 metric tons with P_2O_5 content of 5,000 metric tons valued at $504,000. The soft-rock phosphate was used for direct application to the soil.

Land pebble phosphate was produced at 21 mines by 13 companies in 3 counties. Three of the companies processed tailings debris from previous mining operations. Marketable phosphate rock was produced from land-pebble phosphate mines by Agrico Chemical Co., ASMAC, Borden, Inc., Brewster Phosphates, Florida Agglite Corp., Gardinier, Inc., W. R. Grace & Co., International Minerals and Chemicals Corp. (IMC), Mobil Chemical Corp., Occidental Chemical Co. (Oxy), Swift Chemical Co., T. A. Minerals Corp., and USS Agri-Chemicals.

Agrico Chemical Co. closed down its Saddle Creek mine in March due to slow sales and large rock inventories from its larger operations.

Beker Industries Corp. continued to obtain necessary permits with plans to go onstream with its Manatee County mine in 1980. At yearend, the company lacked only a Manatee County operating permit, which is needed prior to construction.

Borden Chemical Co. continued construction at its Big Four mine in southeastern Hillsborough County. The Big Four mine will produce 1.25 million tons of phosphate rock annually, to be used internally in fertilizer manufacture.

Brewster Phosphates operated its Haynesworth mine in Polk County and its Lonesome mine in Hillsborough County. The Lonesome mine features a two-way, 14,500-foot field conveyor, complete recycling of process water, and use of waste for land reclamation. The facility also uses a 1,500-ton-per-hour wheel excavator and stakes to spread overburden into the areas to be reclaimed.[13]

C. F. Industries obtained a 30-year mining permit from Hardee County to mine its 19,555-acre tract in the county. Two draglines were erected on the site and ground was broken at the mine site in November 1977. A contract was awarded to build a phosphate washer and beneficiation plant. The company has estimated that 80 million tons of minable reserves are on its properties.[14]

Gardinier, Inc., announced that it will construct a $15 to $20 million uranium recovery plant at its East Tampa facility. The plant will utilize solvent extraction in combination with a proprietary process and will produce about 425,000 pounds of yellow cake annually. The plant is scheduled to go onstream in late 1979.[15]

W. R. Grace & Co. started production at its Hooker's Prairie mine in southwestern Polk County. The mine has an annual capacity of 2.8 million tons. Approximately one-half of the production from the Hooker's Prairie mine will be used in a joint venture to manufacture phosphoric acid with USS Agri-Chemicals. During the year, Manatee County approved W. R. Grace & Co.'s Development of Regional Impact Statement request to mine on its 9,800-acre Four Corners tract.

IMC announced that it has a 10-year option on 22,000 acres in southwest Brevard County. It is reported that the deposit contains 300 million tons of phosphate rock, but that there is 60 to 100 feet of overburden on it and it will require mining techniques other than those used in Florida to recover the phosphate. IMC stated that it will build a second $18 million defluorinated phosphate animal feed supplement plant adjacent to the plant under construction. The plant will produce defluorinated phosphate, calcium, and ammonia phosphate.[16]

Mississippi Chemical Corp. continued the long process of permitting required to develop its Hardee County phosphate properties. At yearend, the company and the Regional Planning Council had reached agreement on the company's development of regional impact statement.

Occidental Chemical Co. (Oxy) announced a major expansion of its Florida operations, designed to meet its commitment with the Soviet Union. The initial phase will be to modify the existing facilities and add new installations to supply wet phosphate rock to one phosphoric acid plant, and to modify both phosphoric and sulfuric acid plants to produce 70% phosphoric acid. The estimated cost if $100 million.[17]

Phillips Petroleum Co. and AMAX Chemical Corp. signed an option agreement to purchase 15,000 acres of phosphate land in Manatee and De Soto Counties. Under the agreement, AMAX will continue the engineering, mine evaluation work, and environmental studies. Phillips will complete the work required to obtain final approval of the mining plan from local, State, and Federal authorities.[18]

Swift Chemical Co. continued the permitting process to develop its 10,000-acre phosphate holding in Manatee County.

USS Agri-Chemicals, began operation of its new diammonium phosphate plant at its Bartow complex. The new plant has a design capacity of over 315,000 tons annually.

Several articles were published describing technical advances and economic forecasts.[19] [20] [21]

The Bureau of Land Management offered for sale 840 acres of mineral rights in the central Florida phosphate area. These were widely scattered parcels where the surface was in private ownership. Should a company mine past these small parcels, the phosphate resource would probably be lost because it would not be economic to go back to mine these small areas.

Sand and Gravel.—Sand and gravel production totaled 20 million short tons valued at $39 million. Production increased 53%, and the value increased 103% over that of 1976.

The sand was mainly used for construction purposes with small amounts going into industrial uses. Polk, Charlotte, and Lake were the leading producing counties, accounting for 45% of the output. Polk, Charlotte, and Lake Counties led in value of sand produced and accounted for 46% of the value.

During the year, 47 companies operated 56 mines in 25 counties. Most of the sand was produced by commercial operators. Of the 56 sand and gravel operations, 5 produced between 1,000,000 and 2,500,000 tons, 9 produced between 500,000 and 1,000,000 tons, and 42 produced less than 500,000 tons. Most of the sand and gravel was transported by truck with minor amounts shipped by rail and water.

Table 4.—Florida: Sand and gravel sold or used by producers, by use

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	10,329	$12,958	$1.25	16,869	$29,024	$1.72
Gravel	2,585	4,792	1.85	2,352	4,793	2.04
Total[1] or average	12,914	17,750	1.37	19,220	33,816	1.76
Industrial sand	290	1,414	4.88	997	5,172	5.19
Grand total[1] or average	13,204	19,164	1.45	20,218	38,989	1.93

[1]Data may not add to totals shown because of independent rounding.

Table 5.—Florida: Construction sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	4,355	$6,210	$1.43	12,344	$22,260	$1.80
Concrete products (cement blocks, bricks, pipe, etc.)	3,686	5,398	1.46	1,922	4,010	2.09
Asphaltic concrete aggregates and other bituminous mixtures	674	1,355	2.01	467	1,256	2.69
Roadbase and coverings	1,698	2,498	1.47	2,350	3,873	1.65
Fill	2,342	2,084	.89	1,836	1,903	1.04
Other uses	158	205	1.30	301	515	1.71
Total[1]	12,914	17,750	1.37	19,220	33,816	1.76

[1]Data may not add to totals shown because of independent rounding.

Stone.—Total stone output, including crushed limestone, dolomite, and oyster shell, was 49 million tons valued at $101 million. Florida ranked fifth in the Nation in crushed stone output.

Crushed limestone output increased 26% and its value increased 37%, reflecting the turn around in the building construction industry that was indicated by a stabilization and upturn in 1976. The stone was produced by 73 companies from 127 quarries in 25 counties in 1977, compared with production from 65 companies from 122 quarries in 24 counties in 1976. Dade, Hernando, and Broward, in that order, were the principal producing counties supplying 59% of the total production and accounting for 60% of the value. Of the total crushed limestone sold or used by producers, 33% was used for concrete aggregate; 32%, for dense-graded road base; 9%, for bituminous aggregate; 5%, for cement manufacture; 2%, for agricultural uses; and the remainder for miscellaneous uses. Three companies processed oyster shell for roadbase material. One company quarried dimension limestone for rubble.

Table 6.—Florida: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	12,610	28,020	15,980	39,983
Dense-graded roadbase stone	13,754	19,480	15,410	23,164
Bituminous aggregate	2,518	5,107	4,440	10,190
Roadstone	2,525	4,486	3,085	7,409
Cement manufacture	1,825	2,509	2,554	3,173
Fill	867	1,029	2,342	2,722
Surface treatment aggregate	1,932	5,554	2,106	6,101
Agricultural limestone	1,104	3,444	1,019	3,529
Macadam aggregate	266	430	578	1,519
Railroad ballast	63	118	W	W
Riprap and jetty	212	832	61	291
Filter stone	W	W	44	W
Other uses[2]	931	3,398	937	3,357
Total[3]	38,606	74,412	48,558	101,435

W Withheld to avoid disclosing individual company proprietary data; included with "Other uses."

[1] Includes limestone and shell.

[2] Includes stone used for mineral food, lime manufacture, other filler (1976), soil conditioners, other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Staurolite.—Staurolite was recovered as a byproduct of ilmenite production at the Highland and Trail Ridge plants of E. I. du Pont de Nemours & Co. in Clay County. Both output and value increased over the 1976 level. It was principally used in sandblasting, and minor amounts were used for cement. Florida was the only State with a recorded production of staurolite.

Sulfur.—Recovered sulfur from petroleum production at Exxon's desulfurization plants in Santa Rosa County increased compared with 1976 levels. The value of byproduct sulfur is not included in the State's mineral production value.

Vermiculite.—Exfoliated vermiculite was produced by two operators at four plants in Broward, Duval, and Hillsborough Counties from crude ore shipped into the State. The exfoliated vermiculite was used for lightweight aggregate, plaster aggregate, insulation, and other purposes. The value of vermiculite is not included in the State's mineral production value.

METALS

Metals accounted for less than 2% of the State's total mineral production value.

Rare-Earth Minerals.—Humphrey's Mining Co., Nassau County, and Titanium Enterprises, Clay County, produced monazite concentrate. Production and value remained at the same level as in 1976.

Titanium Concentrates.—Titanium Enterprises produced rutile from its Green Cove Springs plant. Output increased over that of 1976. E. I. du Pont de Nemours & Co. and Titanium Enterprises produced ilmenite from their plants in Clay County, and Humphrey's Mining Co. produced ilmenite concentrates from its mine in Nassau County.

Zircon Concentrates.—Production of zircon concentrates from E. I. du Pont de Nemours & Co.'s Trail Ridge plant and Titanium Enterprises Green Cove Springs plant, both in Clay County, increased while the value decreased from 1976 levels.

MINERAL FUELS

Mineral fuels produced were natural gas, natural gas liquids, and crude petroleum. These commodities accounted for 41% of the total State mineral production value in 1977.

During 1977, 13 wildcat and 17 field development wells were drilled in Florida. Of these, 16 produced oil and 14 were dry holes. Four of the wildcat wells resulted in production, three from the Sunniland Limestone formation of Lower Cretaceous (Glen Rose) age in south Florida and one from the Smackover Formation of Jurassic age in west Florida.

Two of the south Florida wildcat wells were designated the discoveries of Baxter Island field and Raccoon Point field, both in Collier County; the third was the discovery of a yet-unnamed field in Hendry County.

The fourth wildcat productive of oil was designated the discovery well of the Sweetwater Creek field in the Blackwater River State Forest in Santa Rosa County located in west Florida.

The cumulative total production from Florida fields from the initial discovery at Sunniland, Collier County, in 1943, through December 1977 was 243,033,000 barrels of oil and 232,122 million cubic feet of natural gas. Of this amount, 85% of the oil and 88% of the natural gas was produced from Jay field. It is calculated that about one-half of the reserve in the Jay field, recoverable by primary and secondary methods, had been produced at yearend 1977.

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[1] State Liaison Officer, Bureau of Mines, Tallahassee, Fla.

[2] Chief, Bureau of Geology, Florida Department of Natural Resources.

[3] The Tampa Tribune. May 15, 1977.

[4] The Florida-Times Union (Jacksonville). July 20, 1977.

[5] The Tampa Tribune. Sept. 18, 1977.

[6] The Florida Times-Union (Jacksonville). Aug. 20, 1977.

[7] Lanzillotti, R., H. Fishkind, and B. Roberts. Florida Economic Indicators. Florida Economic Forecast — 1978. Bureau of Economic and Business Research, University of Florida, v. 10, No. 1, January 1978, 4 pp.

[8] Kaufmann, R. F., and J. D. Bliss. Effects of Phosphate Mineralization and the Phosphate Industry on Radium-226 in Ground Water of Central Florida. EPA/520-6-77-010, October 1977, 115 pp.

[9] Florida Department of Health and Rehabilitative Services. Study of Radon Daughter Concentrations in Structures in Polk and Hillsborough Counties. January 1978, 100 pp.

[10] Carter, C. E., L. L. Fink, C. M. Teat, and R. C. Herndon. Hazardous Waste Survey. Florida Department of Environmental Regulation, October 1977, 284 pp.

[11] La Fevers, J. R., L. A. Brown, and R. C. Fountain. A Case Study of Surface Mining and Reclamation Planning: International Minerals and Chemical Corporation, Phosphate Operations, Polk County, Florida. Integrated Mined-Area Reclamation and Land Use Planning. Argonne National Laboratory ANL/EMR-1 v. 3B, February 1977, 69 pp.

[12] Tampa Tribune. Dec. 17, 1977.

[13] Pit and Quarry. V. 69, No. 12, June 1977, pp. 52-60.

[14] The Wauchula Herald Advocate. June 9, 1977.

[15] Mining Engineering. V. 29, No. 12, December 1977, p. 17.

[16] Tampa Tribune. Mar. 16, 1977.

[17] The Florida Times-Union (Jacksonville). July 15, 1977.

[18] Sarasota Herald-Tribune. Oct. 12, 1977.

[19] Engineering and Mining Journal. V. 178, No. 9, September 1977.

[20] Engineering and Mining Journal. V. 178, No. 3, March 1977.

[21] Mining Engineering. V. 29, No. 3, March 1977.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Florida Mining & Materials Corp	Box 23965 Tampa, FL 33622	Plant	Hernando.
General Portland, Inc	4400 Republic Nat. Bank Tower, Box 324, Dallas, TX 75221	Plants	Dade and Hillsborough.
Lone Star Florida, Inc	Box 2035 PVS Hialeah, FL 33012	Plant	Dade.
Rinker Portland Cement Corp	Box 650679 Miami, FL 33165	do	Do.
Clays:			
Engelhard Minerals & Chemicals Corp.	Menlo Park Edison, NJ 08817	Open pit mines	Gadsden.
Mid-Florida Mining	Box 68-F Lowell, FL 32663	do	Marion.
Pennsylvania Glass Sand Corp	Berkeley Springs, WV 25411	do	Gadsden.
Gypsum (calcined):			
Celotex Corp	1500 North Dale Mabry Tampa, FL 33607	Plant	Duval.
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	do	Hillsborough.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Duval.
Lime:			
Chemical Lime, Inc	Box 250 Ocala, FL 32670	do	Hernando.
Dixie Lime & Stone Co.[1]	Drawer 217 Ocala, FL 32670	do	Sumter.
Magnesium compounds:			
Basic Magnesia, Inc.[2]	Box 160 Port St. Joe, FL 32456	do	Gulf.
Peat:			
Delta Peat	Box 155 Mango, FL 33550	Bog	Hillsborough.
F. E. Stearns Peat	Rt. 1, Box 542D Dover, FL 33527	Bog	Do.
Superior Peat & Soil	Box 1688 Sebring, FL 33870	Bog	Highlands.
Perlite (expanded):			
Airlite Processing Corp. of Florida	Rt. 2, Box 740 Vero Beach, FL 32960	Plant	Indian River.
Armstrong Cork Co	Box 1991 Pensacola, FL 32589	do	Escambia.
Chemrock Corp	End of Osage St. Nashville, TN 37208	do	Duval.
W. R. Grace & Co.[3]	62 Whittemore Ave. Cambridge, MA 02140	do	Broward.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Petroleum (crude):			
Exxon Co., U.S.A.	Box 2024 Houston, TX 77001	Wells	Santa Rosa.
Sun Oil Co	Box 2880 Dallas, TX 75221	do	Collier and Hendry.
Petroleum (refined):			
Seminole Asphalt Refining, Inc	Box 128 St. Marks, FL 32355	Refinery	Wakulla.
Phosphate rock:			
Agrico Chemical Co	Box 3166 Tulsa, OK 74101	Open pit mines and plants.	Polk.
Borden, Inc	Box 790 Plant City, FL 33566	Open pit mine and plant.	Do.
Brewster Phosphates	Bradley, FL 33835	do	Do.
Gardinier, Inc	Box 3269 Tampa, FL 33601	do	Do.
International Minerals & Chemical Corp.	Box 867 Bartow, FL 38830	Open pit mines	Do.
Mobil Chemical Corp.,[4] a division of Mobil Oil Corp.	Box 311 Nichols, FL 33863	do	Do.
Occidental Chemical Co., a division of Occidental Petroleum Corp.	White Springs, FL 32096	Open pit mine	Hamilton.
Swift Chemical Co	Box 208 Bartow, FL 33830	Open pit mines	Polk.
USS Agri-Chemicals	Box 867 Ft. Meade, FL 33841	Open pit mine	Do.
W. R. Grace & Co.	Box 471 Bartow, FL 33830	Open pit mine and plant.	Do.
Sand and gravel:			
A. J. Capeletti, Inc	Box 4944 Hialeah, FL 33014	Pits	Broward and Dade.
E. R. Jahna Industries, Inc., Ortona Sand Co. Div.	First & East Tillman Lake Wales, FL 33853	do	Glades, Lake, Polk.
Florida Rock Industries, Inc	744 Riverside Ave. Box 4667 Jacksonville, FL 32201	do	Clay, Dade, Glades, Lake.
General Development Corp	1111 South Bayshore Dr. Miami, FL 33131	do	Brevard, Charlotte, Sarasota, St. Lucie.
Staurolite:			
E. I. du Pont de Nemours & Co.	DuPont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Clay.
Stone:			
Florida Crushed Stone Co	Box 668 Ocala, FL 32670	Quarries	Hernando and Sumter.
Florida Mining and Materials Corp.	Box 59351 Miami, FL 33159	Quarry	Hernando.
Florida Rock Industries, Inc	Box 4667 Jacksonville, FL 32201	Quarries	Collier, Lee, Sumter, Suwannee.
Lone Star Florida, Inc.	Box 2601 PVS Hialeah, FL 33012	Plant	Dade.
Southeastern Materials, Inc	Box 2634 Miami, FL 33012	Quarries	Do.
Titanium concentrates:			
E. I. DuPont de Nemours & Co.	DuPont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Clay.
Titanium Enterprises[5]	Green Cove Springs, FL 32043	Mine and plant	Do.

[1] Also stone.
[2] Also lime.
[3] Also phosphate rock and exfoliated vermiculite.
[4] Also elemental phosphorous.
[5] Also zircon concentrate, and rare-earth oxides and thorium oxide in monazite concentrate.

The Mineral Industry of Georgia

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Georgia Department of Natural Resources, Geologic and Water Resources Division.

By Doss H. White, Jr.,[1] and W. Robert Power[2]

Georgia, the largest State in the Eastern United States, ranked 28th in the Nation in the value of industrial minerals produced in 1977. Georgia was first in the production of kaolin, fuller's earth, dimension granite, and crushed granite; second in dimension marble, and crushed marble; third in bauxite and feldspar; and fourth in barite. Nearly all of Georgia's 300 plus mines are open cast. The only underground mines are for marble in Pickens County, dolomitic marble in Gilmer County, and talc in Murray County. The total value of mineral production was a record high of $474 million, an increase of 11% over that of 1976. In the past 10 years, the value of Georgia mineral production has more than tripled.

The first quarter of 1977 was one of the coldest periods in Georgia history and industrial output suffered as a consequence. In order to conserve natural gas for residential use, industrial supplies were restricted to the "plant protection" level. Standby energy sources, usually fuel oil, were used to maintain production where feasible.

Table 1.—Mineral production in Georgia[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland __ thousand short tons__	930	$30,085	1,192	$37,711
Clays ______do____	7,471	273,145	7,554	288,223
Coal, bituminous ______do____	186	6,152	W	W
Sand and gravel ______do____	4,885	8,887	5,141	18,207
Stone ______do____	31,855	98,806	38,105	119,852
Talc ______do____	W	W	23,540	63
Combined value of barite, bauxite, cement (masonry), feldspar, iron ore (1977), kyanite, mica, peat, and items indicated by symbol W ______	XX	11,904	XX	27,200
Total ______	XX	428,479	XX	486,256
Total 1967 constant dollars ______	XX	219,938	XX	^{p}240,016

^{p}Preliminary. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Georgia, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Bacon	W	W	Sand and gravel.
Baldwin	W	W	Do.
Banks	W	--	
Barrow	$44	W	Stone.
Bartow	W	W	Barite, stone, clays.
Bibb	W	W	Clays, sand and gravel.
Carroll	W	W	Stone.
Chatham	287	$511	Sand and gravel.
Chattooga	W	--	
Cherokee	W	W	Mica, sand and gravel.
Clarke	W	W	Stone.
Clayton	W	W	Do.
Cobb	W	W	Stone, sand and gravel.
Coffee	W	W	Sand and gravel.
Columbia	W	W	Clays, stone.
Columbus (city)	W	W	Stone, sand and gravel, clays.
Cook	W	W	Sand and gravel.
Coweta	W	W	Stone.
Crawford	W	W	Sand and gravel.
Dade	W	--	
Decatur	W	W	Clays, sand and gravel.
De Kalb	4,963	6,152	Stone.
Dougherty	174	272	Sand and gravel.
Douglas	W	W	Stone, clays, sand and gravel.
Effingham	W	W	Sand and gravel.
Elbert	W	W	Stone, sand and gravel.
Evans	W	W	Sand and gravel.
Fayette	1,004	1,554	Stone.
Floyd	W	W	Stone, clays.
Forsyth	W	W	Stone, sand and gravel.
Fulton	W	W	Cement, stone, clays, sand and gravel.
Gilmer	W	W	Stone.
Glynn	W	W	Sand and gravel.
Gordon	W	1,250	Stone.
Greene	W	W	Stone, sand and gravel.
Gwinnett	W	W	Stone.
Habersham	W	W	Do.
Hall	W	W	Do.
Hart	W	W	Mica.
Henry	W	W	Stone.
Houston	W	W	Cement, clays, stone.
Jasper	W	W	Feldspar, stone.
Jefferson	W	W	Clays.
Jones	W	W	Stone.
Lee	W	W	Stone, sand and gravel.
Lincoln	W	W	Kyanite.
Lowndes	W	W	Sand and gravel.
Lumpkin	W	W	Stone.
Madison	W	W	Do.
Marion	W	W	Sand and gravel.
Miller	W	3	Peat.
Mitchell	78	--	
Monroe	W	W	Stone.
Murray	W	W	Talc.
Oglethorpe	1,997	1,835	Stone.
Paulding	W	W	Do.
Pickens	12,340	13,756	Do.
Pierce	W	W	Sand and gravel.
Pike	W	210	Do.
Polk	W	W	Cement, stone, clays.
Quitman	W	W	Iron ore.
Rabun	W	700	Stone.
Richmond	W	W	Clays, stone, sand and gravel.
Screven	--	W	Peat.
Seminole	W	W	Sand and gravel.
Spalding	W	W	Stone.
Stephens	W	W	Do.
Stewart	W	--	
Sumter	W	W	Clays, bauxite.
Talbot	447	754	Sand and gravel.
Taylor	729	W	Do.
Thomas	W	W	Clays, sand and gravel.
Tift	W	W	Sand and gravel.
Troup	W	W	Stene.
Twiggs	63,150	76,494	Clays.
Union	W	W	Stone, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Georgia, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Upson	W	--	
Walker	W	W	Stone, clays.
Walton	W	W	Stone.
Ware	W	$204	Sand and gravel.
Warren	$24,915	W	Clays, stone.
Washington	77,078	80,047	Clays.
Wheeler	W	W	Sand and gravel.
Whitfield	W	2,380	Stone.
Wilkinson	39,601	43,513	Clays.
Undistributed[2]	201,550	256,621	
Total[3]	428,479	486,256	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Appling, Atkinson, Baker, Ben Hill, Berrien, Bleckley, Brantley, Brooks, Bryan, Bulloch, Burke, Butts, Calhoun, Camden, Candler, Catoosa, Charlton, Chattahoochee, Clay, Clinch, Colquitt, Crisp, Dawson, Dodge, Dooly, Early, Echols, Emanuel, Fannin, Franklin, Glascock, Grady, Hancock, Haralson, Harris, Heard, Irwin, Jackson, Jeff Davis, Jenkins, Johnson, Lamar, Lanier, Laurens, Liberty, Long, McDuffie, McIntosh, Macon, Meriwether, Montgomery, Morgan, Muscogee, Newton, Oconee, Peach, Pulaski, Putnam, Randolph, Rockdale, Schley, Taliaferro, Tattnall, Telfair, Terrell, Toombs, Towns, Troutlen, Turner, Wayne, Webster, White, Wilcox, Wilkes, and Worth.

[2] Includes some clays and coal that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Georgia business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,211.0	2,259.0	+2.2
Unemployment	do	179.0	156.0	-12.9
Employment (nonagricultural):				
Mining	do	7.0	7.1	+1.4
Manufacturing	do	476.3	488.8	+2.6
Contract construction	do	83.6	87.6	+4.8
Transportation and public utilities	do	116.5	118.8	+2.0
Wholesale and retail trade	do	419.0	433.8	+3.5
Finance, insurance, real estate	do	98.1	99.5	+1.4
Services	do	272.5	281.3	+3.2
Government	do	362.9	372.0	+2.5
Total nonagricultural employment	do	1,835.9	1,888.9	+2.9
Personal income:				
Total	millions	$27,565	$30,358	+10.1
Per capita		$5,531	$6,014	+8.7
Construction activity:				
Number of private and public residential units authorized		24,489	33,543	+37.0
Value of nonresidential construction	millions	$346.0	$473.4	+36.8
Value of State road contract awards	do	$208.5	$215.0	+3.1
Shipments of portland and masonry cement to and within the State	thousand short tons	1,780	2,261	+27.0
Mineral production value:				
Total crude mineral value	millions	$428.5	$486.3	+13.5
Value per capita, resident population		$86	$96	+11.6
Value per square mile		$7,278	$8,259	+13.5

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

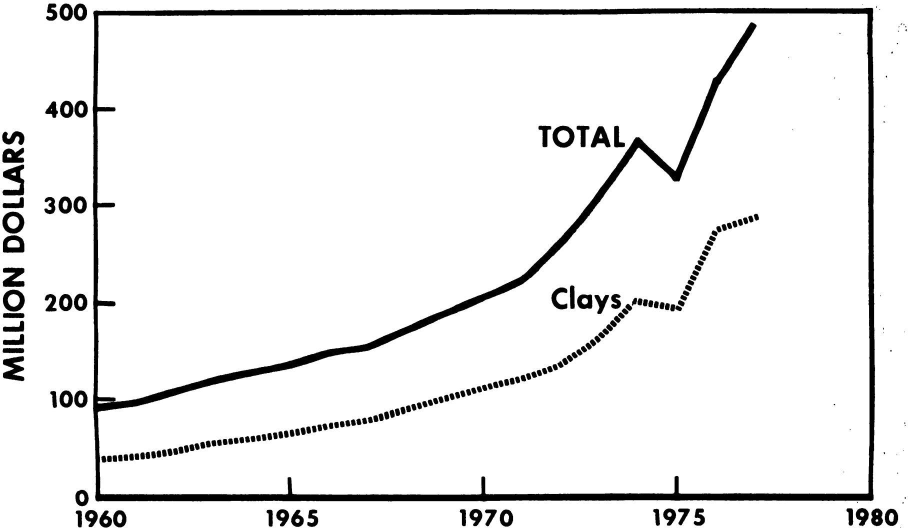

Figure 1.—Value of clays, and total value of mineral production in Georgia.

At the peak of the emergency, gas reserves were depleted by 70% and 75,000 people were out of work. The economic loss was placed at $30 million a week. Most seriously hit were those operations that could not substitute other fuels because of pollution problems. Production of some grades of kaolin was curtailed and some brick companies closed until the shortage ended.

Coal production in the northwestern part of the State was curtailed by the nationwide coal strike. Although the mines are nonunion, pressure from the United Mine Workers of America forced the mines to close in December.

A number of federal programs may affect the State's mineral industry. Georgia kaolin supplied by the Thiele Kaolin Co. was used as a raw material in alumina extraction studies conducted at the U.S. Bureau of Mines Metallurgy Research Laboratory at Boulder City, Nev. Research concentrated on the hydrochloric acid leach process in which alumina is leached from calcined kaolin and then recovered from the acid leach solution.

The Bureau of Mines Metallurgy Research Center in Tuscaloosa, Ala., investigated the firing properties and potential uses of selected clays from Georgia, and additional investigations were undertaken on pretreatment of the Rockmart Slate in lightweight aggregate production. Other studies included pneumatic processing of scrap mica and beneficiation of Georgia coal.

The Water Resources Division, U.S. Geological Survey, investigated the groundwater potential of the Atlanta area and aquifer performance in the coastal plain. In cooperation with the Bendix Corp., a subcontractor to the Department of Energy, the Geological Survey evaluated the uranium potential of four 2-minute quadrangles in the State. Department of Energy officials monitored anomalously high heat flow from a deep petroleum test well that penetrated basement rock in the southern part of the State.

The Forest Service, Department of Agriculture, evaluated 23 tracts of land totaling 233,000 acres for possible Congressional designation as Wilderness Area. The areas under consideration are in north-central and northeastern Georgia and include lands that were once mined for gold, copper, and mica.

On the State level, the Department of Natural Resources, Division of Geology and Water Resources (formerly the Georgia Geological Survey) worked on a number of projects on the geology and mineral resources of the State. The Environmental Protection Division was the lead agency in water quality management planning required under section 208 of the Federal Water Pollution Control Act Amendments of 1972. A technical task force was established to investigate potential areas of nonpoint source water pollution from mining and to develop "best management practices" to mitigate any pollution that might occur.

The Georgia Legislature considered a mineral severance tax on coal which would create a County tax of $0.50 and a State tax of $0.15 per ton of coal produced. Other proposed legislation that would affect the mineral industry included a bill to permit and inspect dams, and a bill concerned with the fair market value of property.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Barite production was limited to the Cartersville District in Bartow County in the northwestern part of the State. Two companies, New Riverside Ochre Co. and Paga Mining Co. accounted for 100% of the ore mined. New Riverside Ochre Co. operates an open pit mine within the city limits of Cartersville and in close proximity to the company's plant on the Etowah River south of the city. New Riverside Ochre production was trucked to Chemicals Products Corp. for use in the manufacture of barium chemicals. Paga Mining Co.'s production was from a mine and from mill tailings left by earlier barite operators. All of Paga's production is sold on the open market for use as fillers and extenders in paint and rubber products, as a weighting medium in drilling muds, glassmaking, fluxes and high-density aggregate. Production decreased from that reported for 1976, while value increased.

Cement.—Cement was manufactured by three companies: Marquette Cement Manufacturing Co. at Rome in the northwest part of the State, Martin-Marietta Cement Corp. in the Atlanta area and Medusa Cement Co. in Clinchfield, south of Macon. Marquette and Martin-Marietta operate dry-process plants while Medusa operates the State's only wet-process facility. In-state production increased 28% over that of 1976. Portland cement is the primary product of the State's cement industry with masonry cement constituting a small fraction of the total production.

Consumption, including approximately 0.4 million tons imported chiefly from Alabama, increased 29% over that of 1976. This was the third highest gain in the Nation.

Clays.—Georgia continued to lead the Nation in the production of clay. Production totaled 7,554,000 tons valued at $288 million, a slight increase over the 7,471,000 tons produced in 1976 which was valued at $273 million. The three leading clay producers were Engelhard Minerals & Chemicals Co., J. M. Huber Co., and the Merry Co., Inc. Georgia's clay production, in order of decreasing value, were kaolin, fuller's earth, common clay, and fire clay.

The kaolin industry was composed of 20 companies operating 52 mines in 7 counties along a southwest-trending "belt" across the central part of the State. Production totaled 4,984,000 tons, an increase of 59,000 tons over that of 1976, and 66% of the total clay produced in the State. This production was valued at $262 million.

Premium grades of kaolin for paper coating and filler applications were leading items during 1977. Freeport Kaolin Co. introduced a new calcined product for the paper market and Anglo-American Clays, Inc., will complete a calcined kaolin facility in 1979. Thiele Kaolin Co. completed an expansion for producing whole fraction fillers and J. M. Huber Co. announced plans to construct a similar facility.

Orders by American Industrial Clay Co., Engelhard Minerals and Chemicals Co., and Georgia Kaolin Co. for magnetic separators for use in kaolin processing will supplement the six currently in operation by the three producers.

Fuller's earth, used predominately as an absorbent and in deodorizing and purifying agents, was produced by seven companies in four counties; five companies produced from pits in Decatur and Thomas Counties in the Georgia-Florida fuller's earth district and two operations produced from pits in Houston and Jefferson Counties in the central part of the State. Production totaled 577,000 tons, a 56,000-ton increase over the 1976 figure. Value was reported at $21.6 million, $3.7 million over that of 1976.

Common clay and shale used in brick, cement, and tile were produced by 14 companies operating 18 pits in 10 counties. Eight operations located in four northwestern counties produced from sedimentary rocks and clays. Three operations in the Atlanta area produced brick and cement materials from phyllonite in the Brevard fault zone. Three operations mine alluvial clays along the Ocmulgee and Chattahoochee Rivers near Macon and Columbus, respectively. The four remaining operations mine phyllonite along the Belair fault near Augusta. Forty-nine percent of the common clay and shale was produced from sedimentary and alluvial sources; fifty-one percent, from metamorphic rock.

Table 4.—Georgia: Kaolin sold or used by producers, by kind and use

(Short tons)

Kind and use	1976				1977			
	Airfloat	Un-processed	Water-washed[1]	Total	Airfloat	Un-processed	Water-washed[1]	Total
Domestic:								
Adhesives	46,091	--	10,214	56,305	38,582	--	18,998	57,580
Alum (aluminum sulfate) and other chemicals	52,982	140,426	49,407	242,815	243	214,941	20,831	236,015
Animal feed	W	--	W	7,598	W	--	--	W
Asphalt tile and linoleum	W	--	--	W	36,128	--	--	36,128
Catalysts (oil refining)	W	W	40,965	91,579	W	--	W	87,046
Cement, portland	--	W	--	W	--	--	--	--
China and dinnerware; crockery and earthenware	r64,700	--	r12,762	r77,462	18,459	--	18,121	36,580
Electrical porcelain	2,564	--	1,469	4,033	W	--	W	23,147
Face brick	--	38,511	22	38,533	W	31,980	W	32,412
Fiberglass and mineral wool	r86,314	--	--	r86,314	58,221	--	--	58,221
Firebrick, block and shapes	4,168	5,760	185	10,113	14,177	13,904	23,457	51,538
Floor and wall tile, ceramic	--	--	3,359	3,359	W	--	W	8,725
Flue linings and high-alumina brick	51,100	8,696	--	59,796	39,327	14,168	--	53,495
Foundry sand	861	--	24	885	1,798	--	100	1,898
Glazes, glass, enamels, and hobby ceramics	W	--	--	W	11,590	W	--	W
Grogs and crudes, refractory	--	423,770	--	423,770	3,024	295,418	--	298,442
Ink	W	--	W	10,555	W	--	W	12,000
Kiln furniture, mortar, and cement	W	17,987	W	19,030	13,745	W	--	W
Medical, pharmaceutical, and cosmetic	502	--	1,567	2,069	W	--	W	1,842
Paint	78,985	--	92,543	171,528	12,413	--	98,754	111,167
Paper coating	14,168	--	1,570,235	1,584,403	63,918	--	1,748,921	1,812,839
Paper filling	92,635	--	733,470	826,105	144,690	--	650,942	795,632
Plastics	4,794	--	54,680	59,474	3,212	--	55,096	58,308
Pottery	--	--	W	W	5,921	--	--	5,921
Roofing granules	32,993	--	--	32,993	W	--	W	19,590
Roofing and structural tile	W	--	--	W	35,561	--	--	35,561
Rubber	72,489	--	8,861	81,350	73,204	--	9,037	82,241
Sanitary ware	40,511	W	W	65,377	108,616	W	W	142,119

See footnotes at end of table.

Table 4.—Georgia: Kaolin sold or used by producers, by kind and use —Continued

(Short tons)

Kind and use	1976				1977			
	Airfloat	Un-processed	Water-washed[1]	Total	Airfloat	Un-processed	Water-washed[1]	Total
Domestic —Continued								
Miscellaneous airfloat:								
Fertilizer; oil and grease absorbents; pesticides and related products; unknown	[r]9,975	--	--	[r]9,975	15,725	--	--	15,725
Miscellaneous, unprocessed:								
Mortar and cement; sewer pipe (1976); and data indicated by symbol W	--	[r]40,757	--	[r,2]113,408	--	31,951	--	[2]22,039
Miscellaneous, waterwashed:								
Gypsum products; mineral oil filtering, clarifying, and decolorizing (1976); pesticides and related products (1977); refractory mortar and cement (1976); waterproofing and sealing; textiles (1976); wire and cable; agriculture (1976); unknown	--	--	[r]87,761	--	--	101,006	101,006	
Undistributed	[r]74,153	--	[r]93,174	(2)	85,632	--	65,406	(2)
Total	729,985	[r]675,907	[r]2,760,698	4,166,590	784,186	602,362	2,810,669	4,197,217
Exports:								
Foundry sand	--	[r]116,525	--	116,525	--	148,406	--	148,406
Paint	--	--	16,038	16,038	--	--	30,714	30,714
Paper coating	6,730	--	298,465	305,195	--	--	507,517	507,517
Paper filling	402	--	230,271	230,673	8,423	--	31,031	39,454
Plastics	--	--	18,601	18,601	--	--	20,348	20,348
Refractories	8,400	--	1,279	9,679	8,300	--	1,739	10,039
Rubber	112	--	40,337	40,449	198	--	862	1,060
Undistributed	408	4,603	15,887	20,898	152	3,850	24,853	28,855
Total	16,052	[r]121,128	[r]620,878	758,058	17,073	152,256	617,064	786,393
Grand total	746,037	[r]797,035	[r]3,381,576	4,924,648	801,259	754,618	3,427,733	4,983,610

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes calcined and delaminated.

[2] Incomplete total; remainder included in totals for specific uses.

Table 5.—Georgia: Kaolin sold or used by producers, by kind

(Short tons)

Kind	1976		1977	
	Quantity	Value	Quantity	Value
Airfloat	746,087	$14,754,411	882,228	$20,709,493
Calcined	787,158	62,089,465	656,058	57,668,552
Delaminated	396,444	27,494,005	420,133	28,960,143
Unprocessed	256,740	3,852,894	308,087	1,077,116
Waterwashed	2,738,269	142,674,174	2,717,104	153,449,022
Total	4,924,648	250,864,949	4,983,610	261,864,326

Table 6.—Georgia: Kaolin sold or used by producers, by use

(Short tons)

Use	1976	1977
Domestic:		
Adhesives	56,305	57,580
Chemicals	242,815	236,015
Fiberglass and mineral wool	[r]86,314	58,221
Firebrick, block and shapes	10,113	51,538
Floor and wall tile, ceramic	3,359	8,725
Paint	171,528	111,167
Paper coating	1,584,403	1,812,839
Paper filling	826,105	795,632
Plastics	59,474	58,308
Rubber	81,350	82,241
Sanitary ware	65,377	142,119
Whiteware	[r]111,354	42,501
Other	[r]868,093	740,331
Exports	758,058	786,393
Total	4,924,648	4,983,610

[r] Revised.

Table 7.—Georgia: Kaolin sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Sumter	W	W	W	W	W	W
Twiggs	5	1,129	63,150	6	1,343	76,494
Warren	3	429	20,239	W	W	W
Washington	6	1,578	77,078	5	1,542	80,047
Wilkinson	7	766	39,601	6	759	43,513
Other counties[1]	5	1,023	50,797	4	1,340	61,810
Total	26	4,925	250,865	21	4,984	261,864

W Withheld to avoid disclosing company proprietary data; included with "Other counties."

[1] Includes Columbia (1977), Houston, and Richmond Counties, and data indicated by symbol W.

Production totaled 1,993,000 tons, down nearly 1% from the 2,016,000 tons produced in 1976. The decrease was due to the shortage of natural gas which forced some producers to close and others to restrict production. Despite the drop in production, the value was reported as $4,807,000, an increase of $500,000 over that reported for 1976.

A number of brick and tile producers investigated the technology for using coal as a primary fuel. The Merry Companies, Inc., of Augusta fired several kilns with sawdust, woodchips, and other lumber mill residue. Sawdust was also mixed with the clay during the extrusion process. This produces additional heat during firing, and a lighter weight product. Savings of up to 40% are realized using this method.

Feldspar.—High-potash feldspar was produced by the Feldspar Corp., a division of Pacific Tin Consolidated Corp., from open pit mines in pegmatite bodies south of Monticello in Jasper County. Ore is trucked to the mill where it is ground and feldspar concentrates recovered by flotation. Concentrates are then shipped by rail to ceramic predueers in 20 States, Canada, and Mexico. Despite dwindling reserves, production increased slightly over that of 1976. The company recently received approval to mine a new deposit in De Kalb County.

Gem Stones.—Georgia staurolite crystals are famous in the mineral collection community, and one company, Georgia Staurolite Mines and Minerals, mixed a weathered staurolite schist which was trucked to an area accessible to the public for staurolite recovery. Additional crystals were recovered by the mine owner for sale in a rock and mineral shop in Ball Ground.

Gypsum.—Gypsum is imported for in-State processing. Three companies, The Flintkote Co., Georgia Pacific Corp., and National Gypsum Co., operated plants in Savannah and Brunswick for the production of wallboard, mineral filler, agricultural soil additives, and cement retarders. Production and value increased over that reported in 1976. American Cyanamid Co. produced gypsum as a byproduct from treating acid waste in a titanium plant in Savannah. A portion of the gypsum was used in a company road stabilization program and additional amounts were sold for agricultural use.

Iron Oxide Pigments.—New Riverside Ochre Co. produced both crude and finished pigments for use in mortar coloring agents, brick and tile, paints and similar products. The company operates one of the two mineral pigment mining and processing facilities in the United States. Production was approximately the same as in 1976.

Kyanite-Mullite.—Kyanite was produced from an open pit mine at Graves Mountain in Lincoln County by C-E Minerals, a division of Combustion Engineering, Inc. Kyanite was concentrated in an onsite flotation plant and trucked to Washington in adjoining Wilkes County for calcining in order to produce mullite refractory grog used primarily by the iron and steel industries. Production increased 5% and value 19% over that reported in 1976.

Synthetic mullite was produced by sintering siliceous bauxite and bauxite-kaolin mixtures by C-E Minerals at a plant near Andersonville in Sumter County. Three grades of refractory products were produced, largely for foreign markets.

Lime.—Lime consumption increased from 196,000 tons in 1976 to 228,000 tons reported in 1977. Although Georgia has abundant high-quality limestone, all the lime used in-state was imported from other southeastern States.

Mica.—For a number of years, mica was produced by two companies. However, in 1977 the Jones Mining Co. in Cherokee County closed because of the cost of meeting federally mandated air pollution standards. The company had operated an underground mine and mill where a sericite schist was ground for use by the paint industry.

Franklin Mineral Products Co. operates an open pit mine and mill in Hart County. The mica is ground for use as an extender and filler in such products as wallpaper, paint, and rubber. Although mica production declined 15%, reported value increased 60%.

Peat.—Two companies in Screven and Miller Counties produced peat for use as a potting medium and general soil conditioner. Production methods consist of draining the upper layers of the deposits, harrowing the surface and stockpiling. Production and value were about equal to that of 1976.

Perlite.—Armstrong Cork Co. operated an expanded perlite plant near Macon in Bibb County to produce material for acoustical tile, pipe insulation, and other lightweight insulating materials. Raw material was obtained from mines in the Western United States. Tonnage value decreased from that reported in 1976.

Sand and Gravel.—The production and sale of sand and/or gravel was reported by 58 companies operating 61 mines in 34 counties. Tonnage and value were reported as 5.1 million and $13.2 million, respectively, compared with the 4.8 million tons valued at $8.4 million reported in 1976. After mining, a number of processing methods were used including washing, screening, desliming, attrition scrubbing, flotation, drying, and sizing to produce a high-quality product for a full range of industrial applications.

Table 8.—Georgia: Construction sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	2,518	$3,624	$1.44	2,896	$6,300	$2.18
Concrete products (cement blocks, bricks, pipe, etc.)	582	1,319	2.27	270	642	2.37
Asphaltic concrete aggregates and other bituminous mixtures	133	372	2.80	639	2,114	3.31
Roadbase and coverings	512	527	1.03	300	590	1.97
Fill	732	574	.78	645	753	1.17
Other uses	45	70	1.56	60	97	1.35
Total[1] or average	4,520	6,484	1.43	4,809	10,496	2.18

[1] Data may not add to totals shown because of independent rounding.

Table 9.—Georgia: Sand and gravel sold or used by producers, by use

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	4,014	$5,643	$1.41	3,496	$6,762	$1.93
Gravel	507	843	1.66	1,313	3,735	2.84
Total[1] or average	4,520	6,484	1.43	4,809	10,496	2.18
Industrial sand	315	1,903	6.04	332	2,711	8.17
Grand total[1] or average	4,835	8,387	1.73	5,141	13,207	2.57

[1] Data may not add to totals shown because of independent rounding.

Stone.—Georgia again ranked first in the production of granite — both crushed and dimension. Georgia was also first in the production of dimension marble and ranked second in total dimension stone and crushed slate.

Crushed stone production increased for the third straight year. It was reported to be 37.9 million tons, an increase of 6.3 million tons over that of 1976, but still 2.9 million tons less than the record year, 1973. The value reached an alltime high of $106 million.

Thirty-one million tons of crushed granite valued at $80 million and produced at 70 quarries located in the northern part of the State accounted for 81% of the crushed stone produced. The leading producers were Vulcan Materials Co., Martin-Marietta Corp., and Ivy Co.

Limestone was produced at 15 quarries located in 5 northwest Georgia counties and 2 coastal plain counties. Production was reported at 4.5 million tons valued at $11 million. Dalton Rock Products was the leading producer followed by Florida Rock Products and Medusa Cement Co.

Tonnage and value of crushed marble and sandstone increased significantly over that reported for 1976. Crushed marble was produced by the Georgia Marble Co. with operations in Pickens and Gilmer Counties in north-central Georgia. Most of the production was ground for use in extender and filler applications and a fraction of the production was sold as agricultural lime. A portion of the stone produced was trucked to Whitfield County in the northwestern part of the State and ground for use by the carpet industry centered around the city of Dalton.

Three companies, Martin-Marietta, Marquette Cement, and The Feldspar Corp., produced a sand product from mining and crushing sandstone or as a byproduct from processing feldspar-rich granite. Major uses were roadbase, concrete, and bituminous aggregates.

One company, Galite, Inc., in northwest Georgia, crushed slate for expanding as a lightweight aggregate. Production and value decreased slightly from that reported for 1976.

Dimension stone was produced by 31 companies at 38 quarries for rough monumental stone, dressed monumental, rough blocks, flagging, and other uses. The State's dimension granite industry was centered in Elbert County northeast of Atlanta, and the dimension marble and dimension sandstone industries were located in Pickens County, north of Atlanta. Output increased to 240,000 tons valued at $14 million. Leading producers were Coggins Granite Industries, Inc., and Georgia Marble Co.

Table 10.—Georgia: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	6,138	14,360	9,750	25,620
Roadstone	6,051	14,930	5,515	14,161
Concrete aggregate	5,950	15,530	7,689	21,130
Bituminous aggregate	5,584	13,660	6,287	16,524
Railroad ballast	2,793	6,868	2,745	6,130
Cement manufacture	1,231	2,363	1,304	2,370
Surface treatment aggregate	795	1,791	687	1,588
Asphalt filler	--	--	79	166
Agricultural limestone	197	626	229	695
Lightweight aggregate	W	1,659	W	2,400
Mineral food	143	437	--	--
Riprap and jetty stone	114	290	89	280
Other uses[2]	2,633	12,880	3,491	15,150
Total[3]	31,630	85,395	37,864	106,215

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes granite, limestone, marble, slate, and sandstone.

[2] Includes stone used for other uses, filler, whiting (1976), terrazzo and exposed aggregate, filter stone (1976), building products, asphalt filler (1976), waste material (1976), macadam aggregate, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 11.—Georgia: Dimension stone[1] sold or used by producers, by use

Use	1976			1977		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough: Monumental	143,900	1,475	$4,940	148,200	1,506	$5,642
Dressed:						
Monumental	20,480	221	5,550	11,919	135	4,541
Rough block	17,940	185	563	17,025	163	509
Irregular-shaped:						
Stone	12,440	158	275	43,568	493	1,510
Rubble	W	W	W	13,000	137	130
Flagging	2,622	34	92	3,162	35	123
Other uses[2]	27,300	300	1,991	3,488	41	1,182
Total[3]	224,680	2,372	13,411	240,461	2,511	13,637

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes granite, sandstone, and marble.

[2] Includes stone used for curbing, dressed construction stone (1976), other rough stone, cut stone, house stone veneer, sawed stone (1976), other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 12.—Georgia: Crushed granite sold or used by producers, by use

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Average per ton	Quantity (thousand short tons)	Value (thousands)	Average per ton
Bituminous aggregate	4,961	$12,274	$2.47	5,251	$14,036	$2.67
Concrete aggregate	5,459	14,399	2.64	6,210	17,545	2.82
Dense-graded roadbase stone	5,466	12,647	2.31	8,407	21,857	2.60
Asphalt filler	--	--	--	79	166	2.10
Surface treatment aggregate	493	1,078	2.18	462	1,034	2.24

Table 12.—Georgia: Crushed granite sold or used by producers, by use —Continued

Use	1976 Quantity (thousand short tons)	1976 Value (thousands)	1976 Average per ton	1977 Quantity (thousand short tons)	1977 Value (thousands)	1977 Average per ton
Unspecified construction aggregate and roadstone	5,521	$13,732	$2.49	4,559	$11,677	$2.56
Railroad ballast	2,766	6,808	2.46	2,588	5,750	2.22
Riprap and jetty stone	94	246	2.62	47	173	3.68
Manufactured fine aggregate	20	40	2.00	W	W	W
Other uses[1]	2,062	5,706	2.77	3,178	8,154	2.57
Total[2]	26,838	66,930	2.49	30,781	80,392	2.61

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes poultry grit, macadam aggregate, and unspecified uses (1976); roofing aggregate, manufactured fine aggregate, macadam aggregate, and unspecified uses (1977).

[2] Data may not add to totals shown because of independent rounding.

Table 13.—Georgia: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976 Quantity	1976 Value	1977 Quantity	1977 Value
Bituminous aggregate	622	1,386	789	1,739
Concrete aggregate	402	890	611	1,325
Dense-graded roadbase stone	672	1,711	658	1,802
Riprap	W	W	28	61
Surface treatment aggregate	301	713	226	553
Unspecified construction aggregate and roadstone	529	1,179	522	1,240
Other uses[1]	1,568	4,369	1,644	4,442
Total[2]	4,094	10,293	4,478	11,162

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes agricultural limestone, railroad ballast, manufactured fine aggregate, terrazzo and exposed aggregate, cement manufactured fine aggregate, terrazzo and exposed aggregate, cement manufacture, other fillers or extenders, and waste material.

[2] Data may not add to totals shown because of independent rounding.

Table 14.—Georgia: Dimension granite sold or used by producers, by county

County	1976 Number of quarries	1976 Thousand cubic feet	1976 Short tons	1976 Value (thousands)	1977 Number of quarries	1977 Thousand cubic feet	1977 Short tons	1977 Value (thousands)
De Kalb	W	W	W	W	W	W	W	W
Elbert	12	499	49,090	$3,718	13	536	52,575	$3,627
Oglethorpe	15	621	58,806	1,997	14	554	54,820	1,835
Undistributed[1]	5	897	87,795	2,526	4	790	78,195	1,943
Total[2]	32	2,017	r195,690	8,241	31	1,881	185,590	7,405

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes De Kalb and Madison Counties.

[2] Data may not add to totals shown because of independent rounding.

Table 15.—Georgia: Dimension granite sold or used by producers, by use

Use	1976			1977		
		Value			Value	
	Quantity (thousand cubic feet)	Total (thousands)	Average per cubic foot	Quantity (thousand cubic feet)	Total (thousands)	Average per cubic foot
Rough:						
Architectural	185	$563	$3.04	163	$509	$3.12
Monumental	1,475	4,940	3.35	1,505	5,642	3.75
Other rough stone[1]	117	161	1.38	137	130	.95
Dressed:						
Curbing	W	W	W	W	W	W
Other dressed stone[2]	240	2,576	20.24	37	1,050	28.38
Total[3]	2,017	8,241	4.09	1,842	7,331	3.98

W Withheld to avoid disclosing company proprietary data; included with "Other dressed stone."
[1] Includes rubble.
[2] Includes monumental stone.
[3] Data may not add to totals shown because of independent rounding.

Strontium.—Celestite, a strontium sulfate mineral, is imported from Mexico by Chemical Products Corp. in Cartersville, in Bartow County. The ore is processed for use in electronics, ceramics, ferrites, television tubes, and other specialty products. Chemical Products Corp. also processes barite preduced by New Riverside Ochre Co. for the production of barium chemicals.

Talc.—The Southern Talc Co. produced talc from two underground mines in the Fort Mountain area of Murray County. The talc is trucked to a mill in Chatsworth where it is ground for use in asphalt, carpet manufacture, composition roofing, and various other products. Production and sales exceeded that reported in 1976. The company also imports barite from Tennessee for processing and use in the carpet industry.

METALS

Bauxite.—Georgia was one of three States producing bauxite in 1977. Two firms produced bauxite from open pit operations in the Andersonville bauxite district in the southwestern part of the State. American Cyanamid Co. mined bauxite for use in the production of aluminum-based chemicals and the Mulcoa Division of C-E Minerals, Inc. mined bauxite for use in refractory grogs. Both companies' operations were located near Andersonville in Sumter County. Bauxite production and value increased while the production and value of synthetic mullite decreased significantly over that produced in 1976.

Iron Ore.—Production of brown iron ore ceased early in 1977. Depletion of known shallow reserves and reclamation costs were the predominant reasons for the closing. Reclamation of previously mined land continued during the year.

Titanium-Zirconium.—Ilmenite and zircon were separated from a heavy mineral concentrate mined in north Florida by the Humphreys Mining Co. at Folkston, 13 miles north of the Florida mine. A heavy mineral concentrate was produced by wet gravity methods at the mine and the concentrates were then trucked to the Folkston plant for final separation. During the year, the company had an active exploration program for new heavy mineral deposits in Georgia.

MINERAL FUELS

Coal.—High-grade metallurgical coal used in coke manufacture was strip-mined from three counties in northwest Georgia. The State continued to have one of the highest stripping ratios in the Nation with one company moving 60 to 70 feet of overburden for 12 to 14 inches of coal. Approximately 50% of the coal was shipped to Brazil's steel industry, and the remainder sold on the domestic market. Production and value increased significantly.

Petroleum.—One oil well was drilled during the year in Wayne County. Although the well was drilled to basement rock at a depth of 4,300 feet, no significant oil or gas shows were observed. However, anomalous high temperatures were recorded near the bottom of the hole, and Department of Energy personnel announced plans to monitor the heat flow as part of the agency's geothermal program.

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[1] State Liaison Officer, Bureau of Mines, Atlanta, Ga.
[2] Professor, Geology, Georgia State University, Atlanta, Ga.

Table 16.—Principal producers

Commodity and company	Address	Type of activity	County
Barite, primary:			
New Riverside Ochre Co	Box 387 Cartersville, GA 30120	Open pit mine	Bartow.
Paga Mining Co	Box 130 Cartersville, GA 30120	do	Do.
Bauxite:			
American Cyanamid Co	Berdan Ave. Wayne, NJ 07470	Open pit mine and plant.	Sumter.
C-E Minerals, Inc	901 East Eighth Ave. King of Prussia, PA 19406	Open pit mine	Do.
Cement:			
Marquette Cement Manufacturing Co	20 North Wacker Dr. Chicago, IL 60606	Plant	Polk.
Martin-Marietta Cement Corp	18th Floor, Daniel Bldg. Birmingham, AL 35233	do	Fulton.
Medusa Cement Co	Box 5668 Cleveland, OH 44101	do	Houston.
Clays:			
American Industrial Clay Co	433 North Broad St. Elizabeth, NJ 07207	Open pit mines	Warren and Washington.
Engelhard Minerals & Chemical Corp	Menlo Park Edison, NJ 08817	do	Decatur.
Freeport Kaolin Co	733 Third Ave. New York, NY 10017	do	Twiggs.
J. M. Huber Co	Thornall St. Edison, NJ 08817	do	Twiggs and Warren.
Feldspar:			
The Feldspar Corp	Box 99 Spruce Pine, NC 28777	Open pit mine and plant.	Jasper.
Gypsum:			
The Flintkote Co	400 Westchester Ave. White Plains, NY 10604	Plant	Chatham.
Georgia Pacific Corp	Box 311 Portland, OR 97207	do	Glynn.
National Gypsum Co	327 Delaware Ave. Buffalo, NY 14202	do	Chatham.
Kyanite:			
C-E Minerals, Inc	433 South Gulph Road King of Prussia, PA 19406	Open pit mine and plant.	Lincoln.
Mica:			
Franklin Mineral Products Co., Inc	Box O Wilmington, MA 01887	Open pit mine	Hart.
Peat:			
Shep Peat Co	Box 307 Colquitt, GA 31737	Bog	Miller.
Perlite, expanded:			
Armstrong Cork Co	1010 Concord Lancaster, PA 17604	Plant	Bibb.
Sand and gravel:			
Brown Brothers Sand Co	Howard, GA 31039	Open pit mines	Talbot and Taylor.
Claussen-Lawrence Construction Co	Box 4510 Augusta, GA 30907	Open pit mine	Richmond.
Colwell Construction Co	Box 6 Blairsville, GA 30512	do	Upson.
Crawford County Mining Co., Inc	3166 Maple Dr. Atlanta, GA 30305	do	Crawford.
Dawes Silica Mining Co	Box 470 Thomasville, GA 31792	Open pit mines	Dougherty, Effingham, Thomas.
Howard Sand Co	Box 118 Butler, GA 31006	do	Talbot and Taylor.
The Scruggs Concrete Co., Inc	Box 2065 Valdosta, GA 31601	Open pit mine	Cook.
Stone:			
Dalton Rock Products Co	Box 1608 Dalton, GA 30720	Quarry	Whitfield.
Davidson Mineral Properties, Inc	Box 458 Lithonia, GA 30058	Quarries	De Kalb and Fulton.
Dixie Lime & Stone Co	Box 998 Bridgeboro, GA 31744	do	Clayton, Fayette, Mitchell, Monroe.
Georgia Marble Co	3460 Cumberland Pkwy., N.W. Atlanta, GA 30303	do	Gilmer and Pickens.
Vulcan Materials Co	Box 7324-A 1 Office Park Birmingham, AL 35223	do	Cobb, Douglas, Fulton.
Talc:			
Southern Talc Co	Box F Chatsworth, GA 30705	Mines and mill	Murray.

The Mineral Industry of Hawaii

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Hawaii Department of Land and Natural Resources for the collection of mineral data.

By John R. McWilliams[1]

Value of mineral production in Hawaii decreased 5% or $2.3 million from the 1976 level to $40.0 million in 1977, reflecting a decline in production in all mineral commodities other than sand and gravel. Sand and gravel increased 35% in production and 50% in value. Output of portland cement declined 2% in production and 8% in value; masonry cement declined 9% in production and 8% in value. Other commodities that decreased in production include the following: pumice, which deccreased 21% in production and 10% in value; stone, 5% in production and 6% in value; lime, which was produced in one plant on the Island of Maui, and precious coral, which registered a slight decrease in value. In addition, one plant in Honolulu produced exfoliated vermiculite from imported ore, and a small amount of sulfur was produced in the refining of oil.

Stone had the greatest value and accounted for 50% of the mineral value produced in the State. Portland cement was second (41%), and sand and gravel was third (6%). Other minerals include masonry cement, pumice, lime, clays, and gem stones with a combined value of $1,333,000 accounting for 3%.

Table 1.—Mineral production in Hawaii[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Cement:				
Portland ______ thousand short tons__	328	$17,747	320	$16,315
Masonry ________________do____	11	663	10	607
Pumice_________________do____	330	636	260	574
Sand and gravel ______________do____	573	1,634	771	2,452
Stone_____________________do____	[2]6,092	[2]21,193	5,759	19,880
Combined value of other nonmetals ______	XX	379	XX	152
Total_______________________	XX	42,252	XX	39,980
Total 1967 constant dollars ________	XX	21,688	XX	[p]19,734

[p]Preliminary. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes dimension stone; included in "Combined value" figure.

Cement which was manufactured at two plants in Honolulu County, was used primarily in ready-mix concrete. Pumice, produced on the Islands of Hawaii, Maui, and Kaui from 17 mines and 4 plants, was used in road construction, concrete aggregate, and landscaping and fill. A new $9.5 million manmade sand plant on Oahu will provide an alternative to mining beach sand to supply the construction needs of the State. Stone was produced by 21 companies from 33 quarries in the counties of Hawaii, Honolulu, Kaui, and Maui.

Vermiculite imported from Montana was exfoliated in Honolulu for use in roofing aggregate, soil conditioner, and concrete aggregate. Common clay was mined for brick near Ewa, Honolulu County. Black, pink, and gold coral was harvested in offshore waters for use in making fine jewelry. One company on Maui produced lime hydrate used in the sugar industry.

Table 2.—Value of mineral production in Hawaii, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Hawaii	W	W	Stone, pumice, sand and gravel.
Honolulu	$34,256	W	Cement, stone, clays.
Kauai	W	W	Stone, sand and gravel, pumice.
Maui	3,092	$3,756	Sand and gravel, stone, pumice, lime, gem stones.
Total[1]	42,252	39,980	

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Hawaii business activity

	1976	1977[p]	Change percent
Employment and labor force, annual average:			
Total civilian labor force thousands	397.0	404.0	+1.8
Unemployment do.	39.0	30.0	-23.1
Employment (nonagricultural):			
Mining do.	(1)	(1)	--
Manufacturing do.	23.4	23.3	-.4
Contract construction do.	21.4	19.6	-8.4
Transportation and public utilities do.	27.1	28.2	+4.1
Wholesale and retail trade do.	87.9	90.8	+3.3
Finance, insurance, real estate do.	24.7	24.6	-.4
Services do.	[2]79.9	[2]84.8	+6.1
Government do.	84.8	85.7	+1.1
Total nonagricultural employment do.	349.2	357.0	+2.2
Personal income:			
Total millions	$6,252	$6,773	+8.3
Per capita	$7,183	$7,677	+6.9
Construction activity:			
Number of private and public residential units authorized	8,225	7,916	-3.8
Value of nonresidential construction millions	$117.3	$128.8	+9.8
Value of State road contract awards do.	$31.1	$51.0	+64.0
Shipments of portland and masonry cement to and within the State thousand short tons	338	318	-5.9
Mineral production value:			
Total crude mineral value millions	$42.3	$40.0	-5.4
Value per capita, resident population	$48	$45	-6.3
Value per square mile	$6,551	$6,198	-5.4

[p] Preliminary.

[1] Included with "Services."

[2] Includes mining.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Kaiser Cement & Gypsum Corp. operated a cement plant near Nanakuli, and Cyprus Hawaiian Cement Corp. operated a cement plant near Ewa, both on Oahu Island in Honolulu County. Total production of portland cement was down 2% from the 1976 level. The total value was 8% less than that of 1976. Masonry cement production declined 9% and value was 8% less than that of 1976.

Of the total amount of portland cement produced, 87% was used in ready-mix concrete, 5% was used by contractors other than highway, 4% by building materials dealers, 3% by government agencies and miscellaneous customers, and 1% by concrete product manufacturers. In contrast to 1976, when 2% of the total production was used in highway construction, none was used for this purpose in 1977.

Raw materials consumed in the production of portland cement included 445,000 tons of calcareous materials, 57,000 tons of argillaceous material, 33,000 tons of siliceous material, and 16,000 tons of gypsum.

The two cement plants consumed 253,000 barrels of fuel oil and purchased 50 million kilowatt hours of electrical energy.

Clays.—Pacific Clay Corp. mined common clay near Waimanalo, Honolulu County, and used it for making brick in Campbell Industrial Park near Ewa, Honolulu County.

Gem Stones.—Black, pink, and gold coral was harvested in the waters surrounding the Hawaiian Islands to provide raw material for local jewelry manufacturing. The industry employs over 500 people. The major jewelry producer, Maui Divers of Hawaii, Ltd., was acquired by Helena Rubenstein in 1977. Its whollyowned subsidiary, Deep Water Explorations, Ltd., handles diving and coral-collecting operations. The company harvests pink coral off Makapuu in the Molokai Channel with a deep-diving submarine to depths of 1,200 feet. Black coral is harvested in the waters of Maui and Kauai Islands by independent scuba divers at depths of 150 to 250 feet.

The State Board of Land and Natural Resources has adopted a regulation managing the harvesting of pink and gold coral in the seabeds off Makapuu. The regulation limits the amount of coral that can be taken in a 2-year period to 4,400 pounds and permits the State to order an immediate suspension of operations if necessary for the health and well-being of the coral colonies. In addition, the regulation requires that coral be taken selectively and bans the use of nets, trawls, and explosives for harvesting coral.

Lime.—Only one company produced lime during 1977 compared with two in 1976. The Hawaiian Commercial & Sugar Co., Ltd., produced lime hydrate at Paia, Maui County. Total quantity declined 57% from that of 1976 and value declined 65%.

Pumice.—Production of pumice declined 21% to 260,000 tons valued at $574,000, a decrease of 10% from the 1976 value. Production came from three islands: Hawaii, with nine mines and three plants, 68% of the total; Maui, with six mines and no plants, 28% of the total; and Kaui, with two mines and one plant, 4% of the total production. The principal uses were as concrete aggregate (29%), road construction (57%), and landscaping and fill material(14%).

Sand and Gravel.—Output of sand and gravel increased 35% in 1977, and the value increased 50%. Of the total output, 42% was used as fill, 34% was used as concrete aggregate, 15% was used as asphaltic concrete, and the remainder was used as roadbase and coverings, and in concrete products.

A new $9.5 million manmade sand plant on Oahu is in full operation. Designed to produce 650,000 tons per year on a single shift basis, the plant is capable of supplying the sand requirements of the construction industry throughout Hawaii. The modern, highly automated plant, owned by Honolulu Construction and Draying Ltd. of Honolulu, produced 400 tons per hour of sand from minus 3/8-inch basalt material from the company's modern 600-ton-per-hour crushed stone plant at the Kapaa quarry. The sand plant operation will produce all the sand needed by the company and will eliminate the need to mine beach sand on the Island of Molokai for barging to Honolulu.

Table 4.—Hawaii: Construction sand and gravel sold or used by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	263	$1,137	$4.32
Concrete products	2	9	3.89
Asphaltic concrete	113	748	6.61
Roadbase and coverings	71	120	1.71
Fill	322	438	1.36
Total	771	2,452	3.18

Table 5.—Hawaii: Sand and gravel sold or used by producers

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	369	$1,527	$4.14
Gravel	402	925	2.30
Total	771	2,452	3.18

Stone.—James W. Glover, Ltd. quarried 592 tons of dimension traprock valued at $4,144 for rubble. Twenty-two companies produced crushed stone at 33 quarries for concrete aggregate, roadbase material, cement, and other uses. Output decreased to 5.76 million tons valued at $19.9 million. Leading producers were Honolulu Construction & Drayage, Ltd., Lone Star Industries, and Pacific Concrete & Rock Co. Ltd. Among the States, Hawaii led in the production of dimension traprock.

Hawaiian Bitumels & Paving Co., Ltd. is phasing out its operation at the Kaena quarry. The lease under which the quarry has been operating expired. The company, a major paving contractor in Hawaii, will use its existing inventory of rock supplemented by purchases from local suppliers in the future.

The Maui Planning Commission approved expansion of the Puunene quarry of Ameron Honolulu Construction and Drayage Ltd. from 28 acres to 194 acres. The company was granted a 20-year extension to a special use permit for rock quarrying and processing and the manufacture of concrete products. The Planning Commission was told that only a 2-year supply of rock remained in the original 28-acre parcel and that expansion was essential if the company was to continue to supply rock and concrete products to the construction industry on Maui.

The principal uses of crushed limestone, in order of consumption, were as follows: cement manufacture (67%), manufacture of fine aggregate (10%), dense roadbase (8%), concrete aggregate (8%), unspecified aggregate (4%), and agricultural limestone (2%). Other uses included poultry grit, terrazzo, lime manufacture, chemicals, and porcelain (1%).

Principal uses of crushed traprock were dense roadbase (33%), concrete aggregate (21%), bituminous aggregate (14%), manufacture of fine aggregate (11%), and other uses (21%).

Table 6.—Hawaii: Production of crushed stone,[1] by use

(Thousand short tons and thousand dollars)

Use	1976 Quantity	1976 Value	1977 Quantity	1977 Value
Concrete aggregate	1,500	6,728	1,669	7,512
Dense-graded roadbase stone	730	2,309	1,604	4,490
Cement manufacture	736	1,795	734	1,777
Bituminous aggregate	2,022	6,831	656	2,498
Roadstone	438	1,098	561	1,602
Surface treatment aggregate	151	633	147	565
Agricultural limestone	29	151	22	90
Bedding material	W	W	21	93
Chemicals	10	55	6	33
Mineral food	W	W	3	14
Porcelain	--	--	1	W
Other uses[2]	476	1,592	335	1,206
Total[3]	6,092	21,193	5,758	19,376

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes traprock, limestone, and miscellaneous stone.

[2] Includes stone used for fill, riprap and jetty stone, macadam aggregate, lime manufacture, roofing granules (1977), terrazzo and exposed aggregate (1977), and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Vermiculite.—Vermiculite of Hawaii, Inc., exfoliated vermiculite from Montana at a plant in Honolulu. Output declined about 20% below that of 1976. Of the output, 39% was used in plaster aggregate, 20% for roofing, 20% for soil conditioning, and the remainder, for concrete aggregate, and insulation.

METALS

Manganese.—Deep ocean mining of manganese nodules continues to interest German, French, Japanese, and U.S. firms, some of whom have undertaken deep-sea mining tests in an area southeast of Hawaii in 14,000 to 18,000 feet of water. The black, potato-sized nodules are about 25 weight-percent manganese, but it is their content of about 3% nickel, copper, and cobalt combined that appears to be of most economic significance. Large-scale ocean mining has become economically more attractive because of the rising cost of land ores and of progress in technology development for recovering large quantities of nodules from the deep ocean. Hawaii, which is the nearest point of land to some of the richest areas, is a logical site for a mineral-processing plant. Such a plant would have an important impact on Hawaii's economy because it could provide employment for more than 1,200 people and have an annual revenue estimated at $250 to $300 million. However, three major problems exist and will influence the final decision: Energy, land, and waste disposal. Mineral processing is energy-intensive, and Hawaii imports about 97% of its energy in the form of oil. Siting of a mineral-processing plant at Puna, on the Island of Hawaii, which is being proposed as a potential geothermal energy site, could possibly solve all three of these problems. Puna is located in lava fields of little value for agriculture, and location of a plant here would not be a burden on the Island's limited arable land; the geothermal potential of the site could be developed with the assurance of a ready market for its product; and if the waste material, which comprises 75% of the nodules, were nontoxic, it could be used to cover the lava and make it suitable for agricultural uses, thus increasing rather than diminishing the Island's productive capacity. However, the character of the waste material would depend upon the metallurgical process used.

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[1] State Liaison Officer, Bureau of Mines, Sacramento, Calif.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	Island
Cement:			
Cyprus Hawaiian Cement Corp	1600 Kapiolani Blvd. Honolulu, HI 96814	Cement plant	Oahu.
Kaiser Cement & Gypsum Corp	Waianae Plant 300 Lakeside Dr. Oakland, CA 94666	do	Do.
Clays:			
Pacific Clay Corp	547 Halekauwila St. Honolulu, HI 96813	Open pit mine	Do.
Lime:			
Hawaiian Commercial & Sugar Co., Ltd	Box 266 Puunene, HI 96784	Rotary kiln and continuous hydrator.	Maui.
Pumice and volcanic cinder:			
James W. Glover, Ltd	Box 275 Hilo, HI 96720	Open pit mine	Hawaii.
HC&D, Ltd	Box 190 Honolulu, HI 96810	do	Molokai.
Hilo Coast Processing Co	Pepeekeo, HI 96783	do	Hawaii.
Laupahoehoe Sugar Co	Papaaloa, HI 96780	do	Do.
Sand and gravel:			
HC&D, Ltd	Box 190 Honolulu, HI 96810	do	Molokai.
Louis K. Rego Trucking Co	Lihue, HI 96766	do	Kauai.
Maui Concrete & Aggregates, Inc	8 Central Ave. Wailuku, HI 96793	do	Maui.
Stone:			
Grove Farm Co., Inc	Puhi Rural Station Lihue, HI 96766	do	Kauai.
Hawaiian Bitumuls & Paving Co., Ltd	Box 2240 Honolulu, HI 96804	do	Oahu.
HC&D, Ltd	Box 190 Honolulu, HI 96810	Quarry	Maui and Oahu.
Hilo Coast Processing Co	Box 18 Pepeekeo, HI 96783	do	Hawaii.
James W. Glover, Ltd	Box 275 Hilo, HI 96720	do	Do.
Lone Star Industries	400 Alabama St. San Francisco, CA 94110	do	Do.
Pacific Concrete & Rock Co., Ltd	2344 Pahounui Dr. Honolulu, HI 96819	do	Maui, Molokai, Oahu.
Vermiculite (exfoliated):			
Vermiculite of Hawaii, Inc	842-A Mapunapuna St. Honolulu, HI 96819	Exfoliating plant	Oahu.

The Mineral Industry of Idaho

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Idaho Bureau of Mines and Geology, Idaho Department of Lands, for collecting information on all minerals except fuels.

By D. W. Lockard[1] and E. H. Bennett[2]

Idaho's mineral production in 1977 was valued at nearly $253 million, an increase of 20% over production in 1976. This increase would have been substantially higher if it had not been for labor problems in the Coeur d'Alene district at the Sunshine mine and the Bunker Hill mine and smelter complex. The strike at the Sunshine lasted for the first quarter of the year, while Bunker Hill was shut down the entire summer.

Twenty mineral commodities were produced statewide; 8 were metallic and 12 were nonmetallic or industrial minerals. Production increased from the 1976 level for five metallic and four nonmetallic minerals, and six metallics and six nonmetallics increased in value.

Phosphate rock was the State's leading mineral commodity in terms of value, followed by silver, lead, and zinc. Metallics accounted for about 55% of the total mineral revenue, and nearly 83% of that metallics revenue came from the Coeur d'Alene mining district in Shoshone County.

Idaho ranked 32nd among the 50 States in mineral production value and was the leader in silver and antimony production. The State ranked second in lead and phosphate production, and ranked fourth in the production of vanadium.

As in previous years, most of Idaho's production came from two separate mining areas: The Coeur d'Alene base metal district in Shoshone County and the phosphate rock region in Bingham and Caribou Counties.

In the metallic-producing sector, the strike at Sunshine Mining Co.'s Sunshine mine, which began in March 1976, ended in March of 1977. Full production resumed in June. Sunshine was also the object of a successful corporate takeover by Great Western United Corp., a Colorado firm controlled by Hunt Brothers of Dallas, Tex. In May, The Bunker Hill Mining Co.'s Bunker Hill mining and smelting complex was shut down by a strike that lasted until September. Full production, with the exception of the mine's upper workings, resumed in November. In addition, environmental problems continued to plague Bunker Hill. The Environmental Protection Agency (EPA) has charged the company with polluting Silver Creek and is still negotiating over proposed standards on lead emissions.

Hecla Mining Co. discovered a mineralized zone more than 2 feet wide while exploring the Day, Independence, and Abot properties, from the Lucky Friday mine. Hecla was attempting to lease the Atlas property, which also adjoins the Lucky Friday.

The new Coeur mine, owned by ASARCO Incorporated, reached full production, and development plans were being formulated to explore the American Standard property nearby. ASARCO terminated its lease on the Consolidated Silver project. Day Mines Inc.'s Calladay project, which adjoins ASARCO's Galena mine on the east, is still on standby, awaiting a development agreement. Day continued exploration work at its Tamarack property.

Table 1.—Mineral production in Idaho[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate, antimony content short tons	133	$282	446	W
Clays thousand short tons	W	W	W	W
Copper (recoverable content of ores, etc.) short tons	3,362	4,680	4,052	$5,413
Gem stones	NA	126	NA	100
Gold (recoverable content of ores, etc.) troy ounces	2,755	345	12,894	1,912
Lead (recoverable content of ores, etc.) short tons	53,636	24,780	47,258	29,016
Sand and gravel[2] thousand short tons	6,549	11,504	7,750	15,282
Silver (recoverable content of ores, etc.) thousand troy ounces	11,561	50,292	15,292	70,649
Stone (crushed) thousand short tons	3,462	9,122	3,077	8,005
Zinc (recoverable content of ores, etc.) short tons	46,586	34,473	30,998	21,327
Combined value of barite, cement (masonry and portland), garnet (abrasive), gypsum, lime, perlite, phosphate rock, pumice, sand and gravel (industrial), stone (dimension), tungsten ore, vanadium, and values indicated by symbol W	XX	74,642	XX	100,966
Total	XX	210,246	XX	252,670
Total 1967 constant dollars	XX	107,919	XX	[p]124,718

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes industrial sand; value included in "Combined value" figure.

Table 2.—Value of mineral production in Idaho, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Ada	W	$2,269	Sand and gravel.
Adams	$1,761	1,898	Copper, stone, silver, sand and gravel, gold.
Bannock	W	W	Cement, stone, sand and gravel.
Bear Lake	W	780	Sand and gravel, stone.
Benewah	W	W	Garnet, stone, sand and gravel, clays.
Bingham	W	W	Phosphate rock, sand and gravel.
Blaine	W	W	Barite, silver, lead, zinc, gold, copper.
Boise	1	(2)	Stone.
Bonner	W	W	Sand and gravel, stone, gold, silver, lead.
Bonneville	W	W	Sand and gravel, lime, pumice, stone.
Boundary	37	W	Sand and gravel, stone.
Canyon	W	W	Sand and gravel, lime.
Caribou	43,166	70,768	Phosphate rock, vanadium, stone, sand and gravel.
Cassia	W	W	Sand and gravel, stone.
Clark	W	W	Stone, sand and gravel, clays.
Clearwater	881	412	Stone, sand and gravel.
Custer	2,704	W	Silver, zinc, lead, tungsten, sand and gravel, stone, copper, gold.
Elmore	434	W	Sand and gravel, stone, clays.
Franklin	80	142	Sand and gravel, stone.
Fremont	192	533	Stone.
Gem	897	W	Sand and gravel.
Gooding	462	508	Do.
Idaho	W	1,021	Stone, sand and gravel.
Jefferson	113	422	Stone.
Jerome	W	166	Sand and gravel.
Kootenai	W	W	Sand and gravel, stone.
Latah	W	W	Stone, clays.
Lemhi	W	W	Stone, sand and gravel, gypsum.
Lewis	58	125	Stone.
Lincoln	W	W	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Idaho, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Madison	403	827	Sand and gravel.
Minidoka	W	W	Lime, sand and gravel.
Nez Perce	W	W	Sand and gravel, stone.
Oneida	W	W	Stone, perlite, pumice.
Owyhee	1	W	Silver, gold.
Payette	500	308	Sand and gravel.
Power	31	W	Stone, sand and gravel.
Shoshone	110,977	W	Silver, lead, zinc, copper, antimony, gold, stone.
Teton	--	287	Sand and gravel.
Twin Falls	W	W	Lime, sand and gravel.
Valley	W	W	Stone, sand and gravel, tungsten.
Washington	W	W	Sand and gravel, stone.
Undistributed[3]	47,552	172,198	
Total[4]	210,246	252,670	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Butte and Camas Counties are not listed because no production was reported.

[2] Less than 1/2 unit.

[3] Includes some stone which cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Idaho business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	367.0	390.0	+6.3
Unemployment	do	21.0	23.0	+9.5
Employment (nonagricultural):				
Mining	do	3.3	3.5	+6.1
Manufacturing	do	52.0	53.8	+3.5
Contract construction	do	17.1	19.2	+12.3
Transportation and public utilities	do	17.1	17.9	+4.7
Wholesale and retail trade	do	72.8	76.4	+5.0
Finance, insurance, real estate	do	15.4	16.2	+5.2
Services	do	48.8	51.8	+6.2
Government	do	64.5	66.9	+3.7
Total nonagricultural employment	do	291.0	305.7	+5.1
Personal income:				
Total	millions	$4,729	$5,128	+8.4
Per capita		$5,678	$5,980	+5.3
Construction activity:				
Number of private and public residential units authorized		9,540	12,722	+33.4
Value of nonresidential construction	millions	$80.7	$106.3	+31.7
Value of State road contract awards	do	$46.5	$50.0	+7.5
Shipments of portland and masonry cement to and within the State	thousand short tons	513	512	-.2
Mineral production value:				
Total crude mineral value	millions	$210.2	$252.7	+20.2
Value per capita, resident population		$253	$295	+16.6
Value per square mile		$2,516	$3,024	+20.2

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

In other developments in the Coeur d'Alene district, the Sidney, Mascot, and Nabob mines were operated under lease by Intermountain Engineers, Inc. The 250-ton Nabob mill was rehabilitated and produced concentrates from the Little Pittsburgh mine. Development work continued at the Goldback claims east of Murray, the Royal Apex property north of Osburn, and the Daybreak mines property adjacent to Callahan Mining Co. holdings.

Outside the Coeur d'Alene district, the pouring of a large dore button signified the opening of the new DeLamar mine in Owyhee County. At full production, this open pit mine is expected to produce 2.5 million ounces of silver and nearly 20,000 ounces of gold annually. The mine is operated by Earth Resources Co. in a joint venture with Canadian Superior Mining (U.S.), Ltd. and Superior Oil Co. Sidney Mining Co. leased its holdings adjacent to the DeLamar mine to ASARCO, but the lease was later dropped. Anglo-Bomarc Mines, Ltd. and Canadian Superior Mining (U.S.), Ltd. carried out an evaluation program on the Hercules property in Adams County. Sun Valley Lead-Silver Mines completed 500 feet of developmental work at its New Hope mine (Blaine County). In Custer County, Exxon Corp. completed exploration drilling at its Empire mine near Mackay. Also, serious consideration was given to reopening the Hoodoo mine (Custer County) on Slate Creek. Canadian Superior Mining continued evaluation of the Stibnite district in Valley County for its gold potential. Shoshone Silver mines continued developmental work in the Lakeview mining district in Bonner County. Noranda Mines, Ltd., has indicated it may seek an option for the Blackbird mine and Iron Creek properties (Lemhi County) owned by Hanna Mining Co.

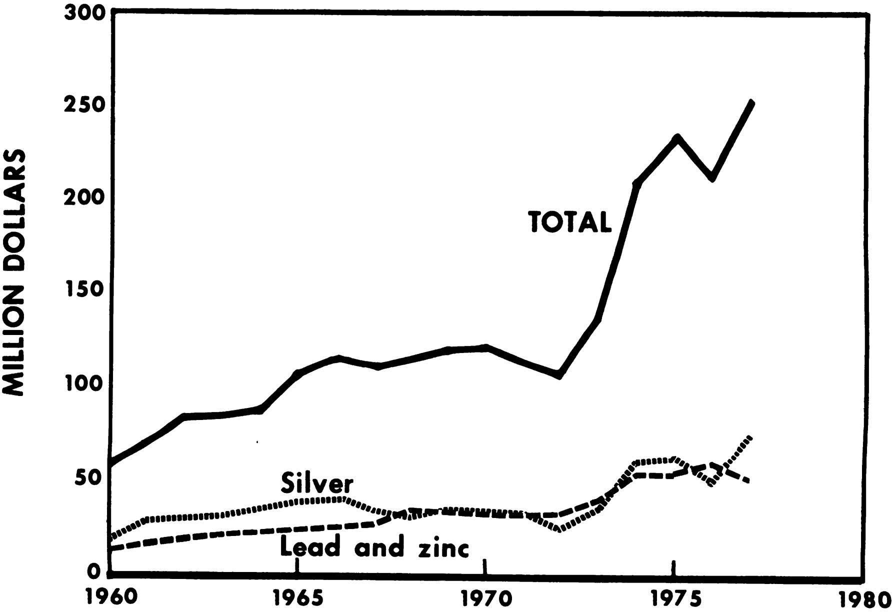

Figure 1.—Value of silver, lead and zinc, and total value of mineral production in Idaho.

Mineral exploration in the State expanded significantly, compared with exploration during 1976. Early estimates of exploration expenditures for all minerals exceeded $20 million. Several companies continued exploration and developmental work on molybdenum properties throughout the State. Bear Creek Mining Co. and Cominco Ltd. have done some developmental work on the molybdenum mineralization on Chilco Mountain in northern Kootenai County; Cominco has been active on its molybdenum property near Napoleon Hill in Lemhi County; and Union Carbide Corp. has done some developmental work on its property next to the Bear Creek-Cominco claims. Developmental work was continued by AMAX on a molybdenum deposit in Boise County near Grimes Pass, on the north side of Boise Basin and south of the South Fork of the Payette River. Also, Cyprus Mines Corp. (Tuscarora Mining Corp.) continued surface and underground drilling, metallurgical testing, and feasibility studies on its molybdenum property on Thompson Creek, a tributary of the Salmon River between Challis and Clayton in Custer County.

Rising prices have resulted in intensified exploration for uranium, especially in northern Idaho. Companies active throughout the western panhandle in Boundary and Bonner Counties include Pechiney and Continental Oil Co. A reconnaissance geochemical stream-sediment sampling was done during the fall in the watersheds of Benewah, Latah, Kootenai, and Shoshone Counties. This sampling was conducted by the Geoenergy Co. of Las Vegas under a Department of Energy (DOE) contract in support of the National Uranium Resource Evaluation program.

A preliminary DOE report on the uranium and thorium content of intrusive rocks in northeastern Washington and northern Idaho has been released by Bendix Field Engineering Corp. Much of Idaho's panhandle has been surveyed for radioactive minerals using an airborne gamma spectrometer and stream-sediment, soil, and rock-sample geochemical techniques. Bendix also released a report on radioactive placers in the Big Meadow Area in Valley and Blaine Counties. Other potential sources of uranium are areas near Hailey and north of Sun Valley in Blaine County. Wyoming Minerals Corp., St. Joe American, Utah International Inc., Lucky Mc, and Exxon are active in these areas. Phillips Petroleum Co. reportedly drilled several holes south of Salmon near Sevenmile Creek.

The Challis volcanics in this area could prove to be the uranium-bearing rock units that are now being sought. Carbonaceous layers and sedimentary interbeds in these volcanics at other locations are known to contain uranium, for example, near the Stanley Basin at the north end of the Sawtooth Mountains.

In the nonmetallic sector, the predicted growth of the State's phosphate industry failed to materialize. As outlined in the final Environmental Impact Statement (EIS) released in October, seven companies had expressed an interest in expanding or starting 16 new mining operations; however, these plans appear to have been postponed because of a sharp drop in sales of elemental phosphorous and phosphate fertilizer.

Double Eagle Petroleum Co. of Casper, Wyo., was investigating zeolite deposits in Owyhee County. Ethel Corp. withdrew its application for patents on kyanite deposits on Woodrat Mountain in Clearwater County. Ethel was also working on claims that cover an anorthsite body in Shoshone County.

In 1977, mineral processing within the State added an estimated $350 million to the value of raw mineral products, a considerable drop from the value added in 1976. The 5-month strike at the Bunker Hill smelter complex was primarily responsible for this reduction.

Of the 9,000 people employed in the State's mineral industry in 1977, an estimated 4,200 were directly involved with mineral extraction, and 4,800 were associated with mineral reduction and processing. Average weekly gross earnings for those employed directly in mining amounted to $332. These mining personnel ranked second in earnings in the State, slightly behind personnel in the construction industry.

No fossil fuels were produced in the State during 1977. At yearend, four exploratory oil and gas wells were in progress; two of these were started in late summer. The exploratory drilling was confined to part of the Willard Overthrust Belt in southeastern Idaho, in Caribou and Bonneville Counties. The outlook is very encouraging for gas production in this area. The Idaho State Land Board approved extensions for oil and gas leases for which the 5-year development clause is due or past due; the extensions were granted to the end of 1978. Since 1903, an estimated 110 dry oil and gas wells have been drilled in the State. Coal exploration and development in Teton County remained at a standstill. An attempt was made to consolidate private coal rights and leases.

Legislation and Government Programs.—Proposed Federal laws, regulations, and land-use classifications caused a great deal of concern in the mineral sector. Revision of the General Mining Law of 1872 is before Congress. The Bureau of Land Management released proposed regulations for hard-rock mining on public lands and regulations pertaining to recordation of mining claims. The hard-rock regulations were not promulgated in final form but the recordation regulations were. Amid controversy, the U.S. Forest Service, which controls 39% of the land in Idaho, initiated new studies of roadless areas (RARE II) for possible inclusion in the national Wilderness System. Public input was solicited at workshops across the State in regard to the 8.2 million acres, or 24% of all Federal lands, that was involved. A special area, the

Gospel Peak-Buffalo Hump region in Idaho County, was the subject of public hearings and was added to H.R. 3454 as an instant wilderness area. A dispute over ambient air standards for smelter discharges is still unresolved between the EPA, the State of Idaho, and The Bunker Hill Co.

The 44th Idaho Legislature, 1st Regular Session, dealt with several significant State issues affecting the mineral sector. A bill was passed to prohibit dredging on the St. Joe River in Shoshone County. The State tax schedule for mine licenses was revised to include phosphate rock and limestone extraction. Some stock issues for small mines are now exempt from securities registration. The Idaho House of Representatives, through House Joint Memorials, petitioned the U.S. Congress to withhold designation of an area in Idaho outside Yellowstone National Park as a critical grizzly bear habitat under the Endangered Species Act. The Idaho House also requested a balanced management objective and rejection of excessive demands for designations of wilderness areas in the Nez Perce National Forest. New legislation was proposed, but remained under committee consideration, that dealt with water quality, water resource management, land use planning, and power plant sitings.

The Bureau of Mines conducted numerous mineral research projects in Idaho. The Spokane Mining Research Center was working on optimum shaft and support design criteria in the Coeur d'Alene district. Field work in the district included stress, deformation, and support-load measurements at the Lucky Friday, Star, Caladay, and Sunshine mines. Preliminary results indicated that deformation around a circular shaft may be less than deformation around a rectangular shaft.

Pillar destressing in advance of mining is being studied at the Star mine as a possible means for preventing rock bursts. The degree of destressing is being measured, and stope closure, stresses, and loads are being monitored throughout the process of mining the stope. A test level was driven through a destressed zone, and few ground control problems were encountered. Limited studies on electrokinetic dewatering and consolidation of underground fill were conducted at mines in the Coeur d'Alene district.

The Bureau's Western Field Operation Center in Spokane conducted mineral studies on the Fort Hall Indian Reservation and the following proposed wilderness areas in the State: Hells Canyon, Salmo-Priest, and the Snake River Wild and Scenic River. The Center also reviewed land use planning documents and environmental impact statements.

The Metallurgical Research Centers at Reno, Nev., Salt Lake City, Utah, and Albany, Oreg., continued research on Idaho mineral resources. Heap leaching techniques of gold-silver rock from Valley, Boise, and Owyhee Counties were tested at Reno and Salt Lake City. The Center in Albany pioneered various recovery experiments on by-product commodities associated with phosphate rock from Bingham, Caribou, and Bear Lake Counties.

The Idaho Bureau of Mines and Geology (IBMG) concentrated its efforts during 1977 on field mapping and reconnaissance geochemical studies. Ongoing programs included the mapping and sampling of the Trinity Mountain area of Elmore County (in cooperation with DOE) and the geologic study of Owyhee County (in cooperation with the U.S. Geological Survey).

IBMG initiated a mineral evaluation program to provide reconnaissance mineral data for the Gospel Peak-Buffalo Hump area in Idaho County. New publications included the final report on the Blackbird Mountain-Panther Creek area in Lemhi County (IBMG Pamphlet 167).

A Bureau of Mines-funded grant was given to the University of Idaho to examine the occurrence of leakage from tailings ponds and methods for leakage control. The Bunker Hill tailings ponds were used to determine the amount and location of seepage and the nature of contaminants in the water.

Employment.—Employment in the mineral extraction sector of the State's mineral industry increased slightly in 1977 from that of 1976; the averages for the number of men working and man-hours worked increased less than 1%. Total fatal injuries for the year exceeded the 1976 total by 1, and there were 67 more nonfatal accidents than there were in 1976. Of the four fatal accidents, one occurred in an underground metal mine, and the other three were associated with ore mills. Nondisabling injuries totaled 109 and their frequency rate was 15.85 per million man-hours.

Table 4.—Idaho: Mine employment and injury experience[1]

Year and industry	Average employees working daily	Employee-hours worked (thousands)	Number of disabling injuries reported: Fatal	Number of disabling injuries reported: Nonfatal	Frequency (injury rates per million employee-hours): Fatal	Frequency (injury rates per million employee-hours): Nonfatal
1976:						
Metal	2,507	4,430	2	142	0.45	32.05
Nonmetal	962	1,836	1	24	0.54	13.07
Sand and gravel	356	255	--	1	--	3.92
Stone	319	289	--	1	--	--
Total	4,144	6,811	3	168	0.44	24.66
1977:						
Metal	2,327	4,383	4	213	0.91	48.60
Nonmetal	982	1,801	--	17	--	9.44
Sand and gravel	518	371	--	2	--	5.40
Stone	358	320	--	3	--	9.37
Total	4,185	6,875	4	235	0.58	34.18

[1] All figures final.

Source: Mine Safety and Health Administration, U.S. Department of Labor.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Antimony production more than tripled from 133 short tons in 1976 to 446 short tons in 1977. The value of antimony produced also showed a substantial increase. The increased production resulted from the resumption of operations at the Sunshine mine after a lengthy strike that had affected production during much of the previous year. Idaho ranked first in the Nation in antimony production; it produced 73% of the total U.S. output.

Cadmium.—Idaho's output of cadmium came entirely from The Bunker Hill Co.'s zinc processing plant in Shoshone County. Compared with data from 1976, output decreased 63% and value decreased 55%. These decreases can be attributed to the labor strike that curtailed operations for nearly 5 months during 1977.

Cobalt.—No cobalt was produced in the State, but exploration continued in Lemhi County. Hanna leased the Blackbird mine to Noranda Mines, Ltd., of Toronto, Canada. A new publication released by IBMG indicates other areas in Lemhi County that may have potential for mineralization of cobalt, copper, or both.

Copper.—Production of copper from 18 mines increased 21%, but value rose only 16%. Much of the increased production came from the Sunshine mine, which resumed operations in March after the strike. Three mines produced over $1 million worth of copper. The Coeur d'Alene district produced 76% of the State's copper, and much of the remainder came from the Copper Cliff mine in Adams County.

Gold.—Gold production increased dramatically to 12,894 ounces. Nearly all of this increase came from Earth Resources' DeLamar mine (Owyhee County). Gold production from the base metal deposits in the Coeur d'Alene district remained nearly constant. No gold placer production was recorded for the year.

Lead.—In lead production, Idaho ranked

Table 5.—Idaho: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing (lode)[1]	Material sold or treated (short tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
1975, total	29	1,935,363	2,529	$408,405	13,868,133	$61,297,147
1976, total	29	1,959,630	2,755	345,258	11,561,421	50,292,184
1977:						
Adams	1	150,000	5	742	58,282	269,263
Blaine	4	623	11	1,631	5,034	23,258
Custer	7	88,665	37	5,487	135,358	625,355
Shoshone	11	1,442,176	2,646	392,428	14,273,142	65,941,915
Undistributed[2]	2	396,236	10,195	1,512,020	820,148	3,789,084
Total	25	2,077,700	12,894	1,912,308	15,291,964	70,648,875

	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	3,192	$4,099,129	50,395	$21,669,903	40,926	$31,922,354	$119,396,938
1976, total	3,362	4,680,235	53,636	24,779,910	46,586	34,473,313	114,570,900
1977:							
Adams	923	1,233,153	--	--	--	--	1,503,158
Blaine	(3)	468	18	11,269	10	6,939	43,565
Custer	24	31,408	469	287,832	620	426,672	1,376,754
Shoshone	3,105	4,148,376	46,771	28,717,148	30,368	20,892,918	120,092,785
Undistributed[2]	--	--	(3)	142	--	--	5,301,246
Total	4,052	5,413,405	47,258	29,016,391	30,998	21,326,529	128,317,508

[1] Operations at old mill or miscellaneous cleanups not counted as producing mines.
[2] Includes Bonner and Owyhee Counties combined to avoid disclosing company proprietary data.
[3] Less than 1/2 unit.

Table 6.—Idaho: Mine production of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material, in terms of recoverable metal

Source	Number of mines[1]	Material sold or treated (thousand short tons)	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold, gold-silver, silver[2]	10	968	11,354	11,063	2,616	758	350
Copper	1	150	5	58	923	--	--
Lead, zinc[2]	7	196	1,101	2,603	305	18,620	2,682
Lead-zinc	9	764	434	1,568	208	27,879	27,966
Total lode material	25	2,078	12,894	15,292	4,052	[3]47,258	30,998

[1] Detail will not add to total because some mines produce more than one class of material.
[2] Combined to avoid disclosing company proprietary data.
[3] Data may not add to totals shown because of independent rounding.

Table 7.—Idaho: Mine production of gold, silver, copper, lead, and zinc in 1977, by type of material processed and method of recovery, in terms of recoverable metal

Type of material processed and method of recovery	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Smelting of concentrates	2,705	14,454	4,052	46,980	30,894
Direct smelting of ore and cyanidation[1]	10,189	838	(2)	278	104
Total	12,894	15,292	4,052	47,258	30,998

[1] Combined to avoid disclosing company proprietary data.
[2] Less than 1/2 unit.

second in the Nation, producing more than 47,000 short tons, or nearly 8% of the Nation's newly mined metal. Twenty-two mines accounted for this production; 11 operations in the Coeur d'Alenes produced 99% of the State's output. Production declined 12%, but value increased 17%. The loss of production was attributed to the 5-month strike at the Bunker Hill operation. Outside the Coeur d'Alenes, only the Clayton Silver mine (Custer County), had notable lead production.

Silver.—Production of silver rose 32%, despite labor difficulties in the Coeur d'Alene district. Both the Sunshine and Bunker Hill mines experienced strikes, but production returned to normal levels at yearend. Eleven mines in the district produced 93% of the State's total production; the Sunshine, Galena, Lucky Friday, and Coeur mines produced over 2 million ounces each.

Silver was also mined in Owyhee, Custer, and Adams Counties. The DeLamar mine (Owyhee County) was the only significant producer outside the Coeur d'Alene district.

Idaho ranked first in domestic silver production, accounting for 40% of the U.S. total. At the national level, Idaho's silver mines ranked according to production as follows: (1) Sunshine, (2) Galena, (4) Lucky Friday, (5) Coeur, (12) DeLamar, (13) Bunker Hill, and (14) Star.

Tungsten.—Two mining operations, in Custer and Valley Counties, reported tungsten production for the year. Value received was nearly 7 times more than that of 1976. The quantity produced increased 400%. Exploration for tungsten continued in two other central Idaho counties.

Vanadium.—Production and value of contained vanadium fell about 16% for the year. Vanadium is a byproduct of ferrophosphorus slag from phosphate processing operations in southeastern Idaho. Nearly 63% of the State's ferrophosphorus slag was treated at Kerr-McGee Corp.'s plant at Soda Springs, and the remainder was shipped to Union Carbide's Hot Springs, Ark., facility. Idaho ranked fourth in the Nation in vanadium production.

Zinc.—Zinc suffered a substantial decline in both production and value during the year; production dropped 34%, and value dropped 38%. Eleven mines in the Coeur d'Alene district produced 98% of the State's zinc; the only major producer outside the district was the Clayton Silver mine (Custer County).

The strike at the Bunker Hill mine and smelter was the primary factor responsible for the State's lower production for 1977. Hecla's Star mine surpassed the Bunker Hill mine as the State's leading zinc producer for the year.

Idaho ranked sixth in the Nation in zinc produced.

NONMETALS

Abrasives (Natural).—Idaho's 1977 production of garnet, a natural abrasive, fell 18%, compared with production for 1976; value fell 13%. Two operators in Benewah County, Emerald Creek Garnet Milling Co. and Idaho Garnet Abrasive Co., accounted for the State's total production. These two operations accounted for nearly 8% of the Nation's output of natural abrasives.

Barite.—Rocky Mountain Refractories was the State's only barite producer in 1977. Output from its Deer Park mine (Blaine County) remained constant, but the value received increased 17% over that of 1976.

Cement.—Production of cement by Idaho Portland Cement Co. in Bannock County, the State's only producer, increased 5%, and the value increased more than 26%. Stocks on hand at yearend were lower than in 1976. Numerous cement manufacturers made inquiries within the State regarding the location and extent of limestone deposits that could be used for cement.

Clays.—Clays production in 1977 remained steady, compared with production in 1976, but the value decreased by 53%. More than 50% of the total clay produced was from Benewah County; the remainder came from Clark, Elmore, and Latah Counties. Bentonite and fire clay accounted for less than 27% of the total clay production. Kaolin production was not significant for the year.

Fluorspar.—No fluorspar production was reported in 1977. Domestic Power Development Co. of Idaho Falls finished reconstruction of a mill near Challis in Custer County. The drilling of two additional fluorspar deposits in Custer County was completed.

Gem Stones.—The value of gem stones produced in Idaho was estimated to be $100,000, down 21% from the previous year's value. Opals (Clark County), star garnets (Benewah County), and fire opals and jasper (Owyhee County) were the most sought-after gems.

Gypsum.—Production of gypsum from the Lidy Hot Springs deposit in Lemhi County decreased 48%. Value received also fell considerably. Lidy was the State's only gypsum operation.

Lime.—Production of lime fell 3%, but value rose 28%. Utah-Idaho Sugar Co. and Amalgamated Sugar Co. accounted for the State's total production. Minidoka County was the source of 36% of the State's total lime output, and the remainder came from Bonneville, Canyon, and Twin Falls Counties. The entire output was used for sugar beet processing.

Perlite.—Oneida Perlite Corp. in Oneida County continued to be the State's only producer of perlite. Crude perlite production remained about the same as that in 1976, but value received was up 50%. Nearly half the crude production was used to make expanded perlite, which had increased substantially in value since the previous year. Firewall insulation was the largest use of expanded perlite. During the year, Oneida Perlite Corp. applied for a mineral patent on its perlite mining claims.

Phosphate Rock.—Total marketable production of phosphate rock decreased 7%, but its value increased 51%. Five mines operated during the year, one in Bingham County and four in Caribou County. J. R. Simplot Co.'s Gay mine (Bingham County) was the State's largest phosphate producer. Phosphate ore usage was evenly split between elemental phosphorus and wet-process phosphoric acid.

The final EIS on Idaho phosphate was released during the year; however, the moratorium on leasing was not lifted.

Alumet's phosphate project continued in abeyance; only some detailed exploration work was completed.

Pumice.—Pumiceous material production increased 5%, but total value dropped 9%. Three operations were active during the year: Amcor, Inc., and Producers Pumice in Bonneville County, and Hess Pumice Products in Oneida County. Amcor is the largest pumice producer in the State. All production from Bonneville County was used in concrete aggregate; pumice from Oneida County was used for various abrasives and a concrete admixture.

Sand and Gravel.—Sand and gravel production and value increased 18% and 33%, respectively, for the year. A total of 95 quarries were active during the year. Ada, Canyon, and Bonneville Counties each produced over 1 million tons, and Bear Lake County produced over 500 thousand tons. Five companies produced nearly 34% of the State's total output.

Stone.—Crushed stone for flux stone, roadstone, riprap, and other uses was produced by 19 companies at 67 quarries. Output fell 11% to 3.08 million tons valued at $8 million. Leading producers were the U.S. Forest Service, the State Department of Transportation, and Idaho Portland Cement Co. Bannock County production exceeded 500,000 tons, while each of the following counties produced more than 200,000 tons in 1977: Caribou, Fremont, Idaho, Latah, and Oneida.

Idaho Travertine Corp. quarried dimension marble for rough blocks, rough construction stone, and rubble from quarries in Clark and Bonneville Counties. Dimension stone was less than 1% of the State's total stone output.

Table 8.—Idaho: Construction and industrial sand and gravel sold or used by producers, in 1977

	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	1,926	$3,887	$2.02
Gravel	5,824	11,395	1.96
Total or average	7,750	15,282	1.97
Industrial:			
Sand	W	W	W
Gravel	W	W	W

W Withheld to avoid disclosing company proprietary data.

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[1] State Liaison Officer, Bureau of Mines, Boise, Idaho.

[2] Supervisory geologist, Idaho Bureau of Mines and Geology, Moscow, Idaho.

Table 9.—Idaho: Construction sand and gravel sold or used in 1977, by major use category

	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	2,208	$5,309	$2.40
Concrete products	172	466	2.71
Asphaltic concrete	1,156	3,015	2.61
Roadbase and coverings	3,224	5,265	1.63
Fill	940	1,140	1.21
Other uses	49	89	1.80
Total[1] or average	7,750	15,282	1.97

[1] Data do not add to totals shown because of independent rounding.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
METALS			
Antimony:			
Sunshine Mining Co	Kellogg, ID 83837	Mine and plant	Shoshone.
Copper:			
ASARCO Incorporated	Wallace, ID 83873	Mine and mill	Do.
Silver King Mines, Inc	1204 Deseret Bldg. Salt Lake City, UT 84111	do	Adams.
Gold:			
Earth Resources Co	Box 52 Jordan Valley, OR 97910	do	Owyhee.
Hecla Mining Co	Wallace, ID 83873	do	Shoshone.
Lead:			
The Bunker Hill Co	Kellogg, ID 83837	Mine and plant	Do.
Hecla Mining Co	Wallace, ID 83873	Mine and mill	Do.
Silver:			
ASARCO Incorporated	do	Mine and mill	Do.
Sunshine Mining Co	Kellogg, ID 83837	Mine and plant	Do.
Tungsten:			
R. M. Barrett	Continental Bank Bldg. Salt Lake City, UT 84101	Underground mine	Custer.
Vanadium:			
Kerr-McGee Corp	Soda Springs, ID 83276	Mine	Caribou.
Zinc:			
The Bunker Hill Co	Kellogg, ID 83837	Mine and plant	Shoshone.
Hecla Mining Co	Wallace, ID 83873	Mine and mill	Do.
NONMETALS			
Abrasives:			
Emerald Creek Garnet Milling Co	Fernwood, ID 83830	Mine and plant	Benewah.
Idaho Garnet Abrasive Co	Kellogg, ID 83837	do	Do.
Barite:			
Rocky Mountain Refractories	Hailey, ID 83333	Pit	Blaine.
Cement:			
Idaho Portland Cement Co	Inkom, ID 83245	Plant	Bannock.
Clays:			
A. P. Green Refractories Co	Box 158 Troy, ID 83871	Pit and plant	Latah.
Interpace Co	Ione, CA 95640	do	Benewah.
Gypsum:			
E. J. Wilson & Sons	Dubois, ID 83423	Pit	Lemhi.
Lime:			
Amalgamated Sugar Co	First Security Bank Ogden, UT 84401	Plants	Canyon, Minidoka, Twin Falls.
Utah Idaho Sugar Co	Box 1855 Idaho Falls, ID 83410	Plant	Bonneville.
Perlite:			
Oneida Perlite Corp	Malad City, ID 83252	Pit and plant	Oneida.
Phosphate rock:			
Beker Industries	Box 37 Conda, ID 83230	Pit	Caribou.
J. R. Simplot Co	Pocatello, ID 83201	Mine	Bingham.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
NONMETALS —Continued			
Pumice:			
Amcor, Inc	Box 1141 Idaho Falls, ID 83401	Pit	Bonneville.
Producers Pumice	Ammon, ID 83401	Mine	Do.
Sand and gravel:			
Idaho Concrete Pipe Co	222 Caldwell Blvd. Nampa, ID 83651	Pit	Various.
MONROC	Box 1221 Idaho Falls, ID 83401	Pit	Do.
Stone:			
Deatley Corp	Box 648 Lewiston, ID 83501	Quarry	Bonner.

The Mineral Industry of Illinois

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Illinois State Geological Survey, for collecting information on all minerals.

By Thomas O. Glover[1] and Irma Samson[2]

The 1977 value of mineral production in Illinois, $1,663.3 million, increased 5.2% above the record high of $1,581.2 million set in 1976. Mineral fuels accounted for 78% of the total mineral value; nonmetals comprised 22%; and metals accounted for the remainder. Illinois led the Nation in the production of fluorspar, tripoli, expanded perlite, and iron oxide pigments and ranked third in the production of stone, third in the output of peat, and sixth in the output of sand and gravel.

Output of bituminous coal from Illinois in 1977 was 53.5 million tons, a decrease of 8.1% from that of 1976. Production of crude petroleum was 25.6 million barrels, 0.7 million barrels less than in 1976; in value, petroleum accounted for $314.3 million, 18.9% of the total mineral output of the State. Marketed production of natural gas decreased 35.5% in quantity and 21.5% in value.

Among the nonmetallic mineral commodities, stone ranked first in value, followed by sand and gravel. Combined output of sand and gravel and stone accounted for 14.3% of the State's total noncoal mineral value in 1977. Illinois supplied 77.4% of the total domestic output of fluorspar. Other nonmetallic minerals and mineral products produced in Illinois were barite, cement, clays, gem stones, lime, peat, and tripoli.

Production of lead and zinc, in terms of recoverable metal, increased 2.1% and 9.5%, respectively, from the 1976 figures. Value of lead production increased 36%, and value of zinc production increased 1.8%.

In 1977, Illinois ranked 10th in value of mineral production among the States.

Table 1.—Mineral production in Illinois[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland thousand short tons	1,632	$53,524	1,823	$61,849
Clays[2] do	1,309	3,272	951	5,117
Coal (bituminous) do	58,239	925,968	53,493	924,506
Fluorspar short tons	142,666	14,563	131,218	13,941
Gem stones	NA	2	NA	2
Natural gas million cubic feet	1,556	1,533	1,003	1,204
Peat thousand short tons	87	763	82	1,478
Petroleum (crude) thousand 42-gallon barrels	26,272	267,449	25,608	314,293
Sand and gravel thousand short tons	38,784	87,152	37,633	101,230
Stone do	61,862	141,543	57,077	136,073
Combined value of barite, cement (masonry), clays (fuller's earth), lead, lime, natural gas liquids, silver, tripoli, and zinc	XX	85,396	XX	103,587
Total	XX	1,581,165	XX	1,663,280
Total 1967 constant dollars	XX	811,612	XX	[p]820,995

[p] Preliminary. NA Not available. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes fuller's earth; value included with "Combined value" figure.

Table 2.—Value of mineral production in Illinois, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	W	W	Stone, sand and gravel.
Alexander	W	W	Tripoli, sand and gravel.
Bond	$822	$660	Sand and gravel, clays.
Boone	W	W	Sand and gravel, stone.
Brown	W	W	Stone, clays.
Bureau	1,124	777	Sand and gravel.
Calhoun	W	W	Stone.
Carroll	559	410	Do.
Champaign	943	1,203	Sand and gravel.
Christian	W	1,290	Stone.
Clark	W	2,915	Stone, sand and gravel.
Clay	W	W	Do.
Clinton	W	W	Do.
Coles	5,086	W	Do.
Cook	64,387	69,724	Lime, stone, sand and gravel, clays, peat.
Crawford	W	W	Sand and gravel.
Cumberland	W	W	Do.
De Kalb	W	W	Stone, sand and gravel.
De Witt	W	--	
Douglas	85,648	1,592	Stone.
Du Page	W	W	Sand and gravel, stone.
Edgar	W	--	
Edwards	W	--	
Effingham	W	W	Sand and gravel, stone.
Fayette	25,840	W	Stone, sand and gravel, clays.
Ford	W	W	Sand and gravel, stone.
Franklin	W	--	
Fulton	44,879	749	Sand and gravel, stone.
Gallatin	36,618	W	Sand and gravel.
Greene	W	W	Stone.
Grundy	W	W	Sand and gravel, clays.
Hamilton	W	--	
Hancock	682	761	Stone.
Hardin	22,003	21,690	Fluorspar, stone, zinc, barite, lead, silver.
Henderson	W	1,043	Stone.
Henry	W	W	Do.
Iroquois	W	W	Do.
Jackson	W	W	Do.
Jasper	W	--	
Jefferson	W	--	
Jersey	W	132	Stone.
Jo Daviess	1,415	W	Sand and gravel, stone.
Johnson	W	W	Stone.
Kane	W	12,152	Sand and gravel, stone, peat.
Kankakee	W	W	Stone, clays, sand and gravel.
Kendall	W	W	Stone, sand and gravel.
Knox	W	--	
Lake	W	W	Sand and gravel, stone, peat.

See footnotes at end of table.

Table 2.—Value of mineral production in Illinois, by county[1] [2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
La Salle	W	W	Sand and gravel, cement, stone, clays.
Lawrence	W	$1,154	Sand and gravel.
Lee	W	W	Cement, stone.
Livingston	W	8,730	Stone, clays.
Logan	W	W	Sand and gravel, stone.
McDonough	W	W	Stone, clays.
McHenry	$7,592	14,049	Sand and gravel.
McLean	2,111	2,101	Do.
Macon	W	1,575	Sand and gravel, stone.
Macoupin	W	--	
Madison	W	3,968	Stone, sand and gravel.
Marion	W	W	Stone.
Marshall	W	W	Sand and gravel.
Mason	W	W	Do.
Massac	W	W	Cement, sand and gravel.
Menard	W	W	Stone.
Mercer	W	26	Do.
Monroe	W	W	Do.
Montgomery	W	4,302	Do.
Moultrie	W	W	Sand and gravel.
Ogle	W	1,963	Stone.
Peoria	W	2,280	Sand and gravel, stone.
Perry	W	102	Stone.
Piatt	W	W	Sand and gravel.
Pike	W	W	Stone, sand and gravel.
Pulaski	W	W	Clays, stone, sand and gravel.
Putnam	--	W	Sand and gravel.
Randolph	W	W	Stone, sand and gravel.
Richland	W	--	
Rock Island	W	W	Stone, sand and gravel.
St. Clair	W	W	Do.
Saline	W	--	
Sangamon	W	2,372	Sand and gravel.
Schuyler	W	W	Sand and gravel, stone.
Scott	W	W	Stone.
Shelby	W	W	Sand and gravel, stone.
Stark	W	W	Sand and gravel.
Stephenson	620	683	Stone, sand and gravel.
Tazewell	3,134	2,615	Sand and gravel, clays.
Union	W	W	Stone, sand and gravel.
Vermilion	W	W	Do.
Wabash	W	212	Sand and gravel.
Warren	W	1,683	Stone.
Washington	W	W	Do.
Wayne	W	--	
White	W	597	Sand and gravel.
Whiteside	W	W	Peat, stone, sand and gravel.
Will	14,471	14,362	Stone, sand and gravel.
Williamson	43,157	151	Stone.
Winnebago	2,655	3,178	Stone, sand and gravel.
Woodford	2,978	2,566	Sand and gravel.
Undistributed[3]	1,214,448	1,479,516	
Total[4]	1,581,165	1,663,280	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Cass, Pope, and Morgan Counties are not listed because no production was reported.

[2] Value of petroleum is based on an average price per barrel for the State.

[3] Includes some stone, natural gas, natural gas liquids, petroleum, and coal that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Illinois business activity

	1976	1977^{p}	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ---- thousands--	5,060.0	5,215.0	+3.1
Unemployment ---- do----	331.0	321.0	-3.0
Employment (nonagricultural):			
Mining ---- do----	25.9	26.4	+1.9
Manufacturing ---- do----	1,208.4	1,238.4	+2.5
Contract construction ---- do----	174.4	173.2	-.7
Transportation and public utilities ---- do----	269.4	274.4	+1.9
Wholesale and retail trade ---- do----	1.033.3	1,056.2	+2.2
Finance, insurance, real estate ---- do----	260.0	268.0	+3.1
Services ---- do----	817.1	843.6	+3.2
Government ---- do----	720.5	727.7	+1.0
Total nonagricultural employment ---- do----	4,509.0	4,607.9	+2.2
Personal income:			
Total ---- millions--	$82,073	$87,346	+6.4
Per capita ----	$7,332	$7,768	+5.9
Construction activity:			
Number of private and public residential units authorized ----	59,503	75,374	+26.7
Value of nonresidential construction ---- millions--	$874.5	$1,087.6	+24.4
Value of State road contract awards ---- do----	$335.2	$330.0	-1.6
Shipments of portland and masonry cement to and within the State thousand short tons--	3,877	3,755	-3.1
Mineral production value:			
Total crude mineral value ---- millions--	$1,581.2	$1,663.3	+5.2
Value per capita, resident population ----	$141	$148	+5.0
Value per square mile ----	$28,035	$29,491	+5.2

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

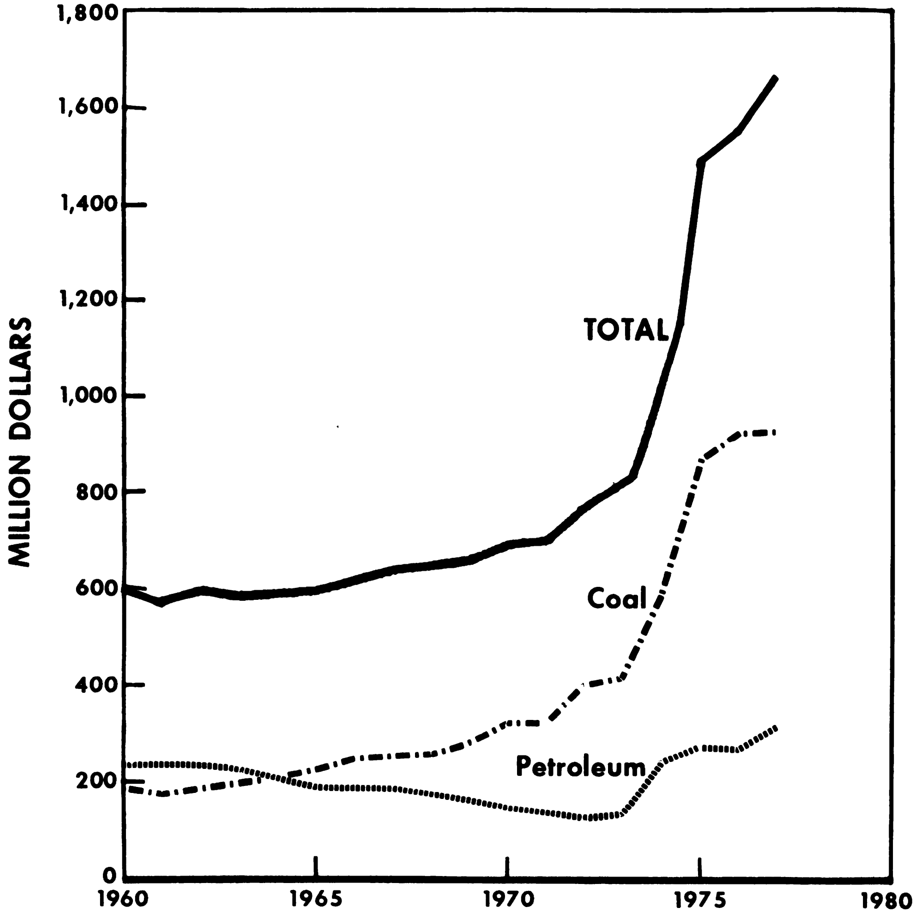

Figure 1.—Value of coal, petroleum, and total value of mineral production in Illinois.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Allied Chemical Corp. recovered a primary barite product at its principal mill near Cave in Rock; the operation is associated with the fluorspar deposits at Allied's No. 1 mine.

Pfizer, Inc., continued to produce ground barite at its East St. Louis plant in St. Clair County.

Cement.—Portland and masonry cements were produced by four companies in 1977. These were the Marquette Cement Manufacturing Co. at its Oglesby plant, La Salle County; the Medusa Cement Co., a Division of Medusa Corp., at its Dixon plant, Lee County; the Missouri Portland Cement Co. at its Joppa plant, Massac County; and the Centrex Corp. at its La Salle plant, La Salle County. Portland cement shipments increased 11.7% in quantity and 15.6% in value; masonry cement shipments increased 21.6% in quantity and 29.4% in value.

Portland cement shipped included types I and II (general use and moderate heat) and type III (high early strength). Raw materials used in making portland cement included limestone, fly ash, clay and shale, sand, gypsum, and slag materials. Disposition of portland cement by type of customer follows: Ready-mix concrete companies (70.5%), concrete product manufacturers (7.6%), building material dealers (6.0%), highway contractors (14.8%), and other users (1.1%).

Clays.—Total production of fire clay and miscellaneous clay and shale decreased 26.9% in quantity and increased 7.9% in value in 1977. Production of fuller's earth decreased in both quantity and value. Production of clay and shale was reported from 11 counties. Fire clay was produced by companies in Grundy and McDonough Counties.

Due to the large increase in construction of single and multifamily housing units, the brick industry and other ceramic industries associated with the construction of housing had their best year since 1973. Industrial construction increased about one-third as much as the housing industry. Due to slowdown in steel production, there also was a slowdown in the refractory industry. Lightweight aggregate sales were slow because of competition from the slag from steel mills.

The management of Illinois Brick Co. stated that Environmental Protection Agency (EPA) regulations caused the firm to close, but it also did not have extensive reserves of clay. American Brick Co., the only brick company operating in the Chicago area, has about 8 years of clay reserves but is having difficulty meeting EPA standards on dust and sulfur fumes.

Red mud from the alumina processing plants in Illinois is a disposal problem, and it has been suggested that the mud be used for brick and/or iron ore. These red mud deposits are over 50% manmade minerals and also contain sodium. These ingredients currently eliminate the red muds from commercial consideration, but if the sodium could be reclaimed economically, the remainder of the red mud might be a possible source of iron ore. The sodium is both an industrial and an environmental problem since some of it may be a pollutant if the wastes are not adequately controlled.

Fluorspar.—Shipments of finished fluorspar totaled 131,218 tons valued at $13.9 million, a decrease of 8.0% in quantity and 4.3% in value compared with the 1976 figures. The State continued to the the Nation's leading producer of fluorspar, supplying 77.4% of the output. The decline in production was due to market conditions; world fluorspar production showed a similar decline.

During the year, two major producers, Ozark-Mahoning Co. and Allied Chemical Corp., and one independent, Hastie Mining Co., continued to operate.

Gem Stones.—Small quantities of gem materials and mineral specimens were collected in 1977. Total value of the materials in 1977 remained about $2,000, the same as the 1976 figure.

Gypsum.—National Gypsum Co. calcined gypsum at the Waukegan plant in Lake County. Output of calcined gypsum in 1977 increased 9.1% in quantity and 32.2% in value over that produced in 1976.

Lime.—Illinois ranked eighth in the Nation in lime production. Marblehead Lime Co. and Vulcan Materials Co. produced lime at three plants in Cook County for steel furnaces, refractories, water purification, sewage treatment, and other uses. Production of lime in 1977 decreased 1.3%, but the total value increased 10.6% over that of 1976. The lime was used in Indiana, Illinois, and other destinations.

Peat.—Illinois produced 80,355 short tons of peat in 1977, 5.1% less than the 84,662 short tons produced in 1976. Production was reported by six companies from Cook, Kane, Lake, and Whiteside Counties.

Sales totaling 82,356 short tons decreased less than 6% from the 1976 sales. Humus, moss, and reed-sedge peat were sold in bulk and packaged forms. Of all sales, 90% were in packaged forms. The majority of the peat was used for general soil improvement; a small amount was used for potting soils.

Illinois ranked third in the Nation in output of peat, accounting for 10.3% of the Nation's total.

Perlite.—Crude perlite mined outside the State was expanded by five companies with plants in Coek, De Kalb, Lake, and Will Counties. Sales of the expanded product decreased 10% in quantity and 23% in value. Principal use was for insulation board, which accounted for 74.0% of the total. Other uses included construction aggregate, filter aid, other insulation, and horticultural and agricultural aggregate. Illinois continued to rank first in the Nation in the production of expanded perlite.

Sand and Gravel.—Production of sand and gravel in 1977 was 37.6 million tons valued at $101.2 million. Over 1 million tons each were produced in Du Page, Grundy, Kane, Lake, La Salle, McHenry, Tazewell, and Will Counties.

Of the total sand and gravel produced, 88.4% was used for construction and 11.6% for industrial use. The average value of the total sand and gravel produced was $2.69 per ton, compared with $2.25 per ton in 1976. The State ranked sixth in the Nation in quantity and fifth in value of sand and gravel produced.

Table 4.—Illinois: Sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	16,628	$31,000	$1.86
Gravel	16,658	37,353	2.24
Total or average	33,286	68,353	2.05
Industrial:			
Sand	W	W	W
Gravel	W	W	W
Total or average	4,347	32,878	7.56
Grand total or average	37,633	[1]101,230	2.69

W Withheld to avoid disclosing company proprietary data.

[1] Data do not add to total shown because of independent rounding.

Table 5.—Illinois: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	13,223	$30,588	$2.31
Concrete products (cement blocks, bricks, pipe, etc.)	1,867	5,083	2.72
Asphaltic concrete aggregates and other bituminous mixtures	5,677	11,366	2.00
Roadbase and coverings	7,113	13,586	1.91
Fill	4,975	6,827	1.37
Railroad ballast	38	91	2.39
Other uses	394	812	2.06
Total or average	[1]33,286	68,353	2.05

[1] Data do not add to total shown because of independent rounding.

Western Materials, Co., a subsidiary of Medusa Aggregates Co., purchased the Lincoln Sand and Gravel Co. in Logan County. Covington Stone Co. took over Keyesport Sand and Gravel in Bond County.

Ottawa Silica Co., one of the world's leading producers of silica sand, put onstream a new sand-processing plant, replacing old facilities, at its St. Peter Sandstone quarry in Ottawa.

Stone.—Illinois, with 57.1 million tons, ranked third in the Nation in the production of stone. The average value of the total stone produced was $2.38 per ton in 1977. Major producing counties, each with production of over 1 million tons, were Cook, Hardin, Johnson, Kane, Kankakee, La Salle, Lee, Livingston, Madison, Montgomery, Rock Island, St. Clair, Union, Vermilion, and Will.

Fox River Stone Co. quarried dimension limestone for house stone veneer, dressed flagging, and rough flagging. Output of dimension stone declined to 2,545 tons valued at $108,900. Crushed limestone was produced by 113 companies at 284 quarries for roadbase aggregate, roadstone, and other uses. Output decreased 8% in 1977 compared with 1976 production. The production of 57.1 million tons of crushed stone was valued at $136 million. Leading producers were General Dynamics Corp., Vulcan Materials Co., and Medusa Corp.

Crushed stone was transported by truck (91.5%), rail (2.7%), water (4.7%), and other (1.1%).

Table 6.—Illinois: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	17,310	38,090	14,651	34,103
Concrete aggregate	10,610	24,250	9,384	21,999
Bituminous aggregate	6,679	15,240	5,571	13,012
Roadstone	6,613	14,240	9,429	20,640
Agricultural limestone	6,613	15,300	4,337	11,233
Surface treatment aggregate	3,927	8,845	4,030	9,122
Macadam aggregate	3,364	7,626	2,836	6,336
Cement manufacture	2,887	5,005	3,065	5,510
Lime manufacture	858	1,749	955	1,948
Riprap and jetty stone	779	1,776	542	1,259
Railroad ballast	648	1,323	640	1,358
Other filler	495	3,842	654	5,972
Flux stone	349	751	351	684
Mineral food	132	1,012	--	--
Fill	106	149	26	35
Asphalt filler	91	350	83	345
Bedding material	5	W	--	--
Other uses[1]	392	1,892	520	2,408
Total[2]	61,858	141,440	57,074	135,960

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes stone used for whiting, glass, mine dusting, chemicals, soil conditioning, and filter stone, and uses indicated by the symbol W.

[2] Data may not add to totals shown because of independent rounding.

Two major stone producers in northeastern Illinois, the Hillside quarry in Cook County and the Lincoln Stone Quarry, Inc. in Will County, terminated operations because of depletion of reserves. Depletion of reserves also led to the closing of Wagner Stone Co. in Livingston County. Covington Stone Co. closed its quarry in Washington County in southwestern Illinois. Pontiac Stone Co. acquired Ocoya Stone Co. and the mineral reserves of Howard Arnold Construction Co., all in Livingston County. Western Materials Co., a subsidiary of Medusa Corp., purchased the Athens quarry in Menard County.

Sulfur (Recovered Elemental).—Sulfur was recovered by Shell Oil Co. at its Hartford refinery in Madison County; by Union Oil Co. of California, Union 76 Div., in Cook County; by Marathon Oil Co. at its Robinson refinery in Crawford County; by Mobil Oil Corp. at its new refinery near Joliet in Will County; by Texaco, Inc., at its Lockport plant in Will County; by Natural Gas Pipeline Co. of America, St. Elmo Pipeline, Fayette County; by Natural Gas Pipeline Co. of America, Herscher Pipeline Storage Div., Kankakee County; and by Texaco, Inc., Lawrenceville plant, Lawrence County. The quantity and value of sulfur recovered from these sources are not included in the mineral production statistics in table 1 because the recovered sulfur is considered a secondary product. Nationally, Illinois ranked sixth in quantity and seventh in value of recovered sulfur shipments.

Tripoli (Amorphous Silica).—Crude material was recovered from underground mines in Alexander County by Illinois Minerals Co. near Elco, and by Tammsco near Tamms. The production of crude material increased 6.4% in quantity and 6.6% in value. Output of prepared materials which was used for abrasives, filler, and other purposes increased 3.9% in quantity and 21.9% in value. Of the few States producing crude tripoli material, Illinois continued to rank first in production and fourth in value.

Vermiculite.—Crude vermiculite mined outside the State was processed by the W. R. Grace & Co. at its West Chicago plant in Du Page County; Mica Pellets, Inc., at its plant in De Kalb County; and International Vermiculite Co. at its plant in Macoupin County. Uses were for loose-fill insulation, block insulation, aggregate in plaster and concrete, horticulture, soil conditioning, fireproofing, fertilizer carrier, and other purposes.

METALS

Iron Oxide Pigments.—Four plants, operating in Adams, Kane, Sangamon, and St. Clair Counties, produced finished (natural and manufactured) iron oxide pigments in 1977. Illinois ranked first in the production of finished iron oxide pigments in 1977. Total output for the State (as indicated by sales) in 1977 decreased in quantity and in value from that of 1976.

Lead and Zinc.—Production of lead and zinc, in terms of recoverable metal, increased 2% and 9.5%, respectively, from the 1976 figures. In terms of value, lead production increased 36% and zinc production increased 1.8%.

Pig Iron and Steel.—About 6.3 million tons of pig iron valued at $1,155.9 million was shipped from Illinois blast furnaces or was consumed by the producing companies, compared with 6.4 million tons valued at $1,119.8 million in 1976. Pig iron was produced by five companies operating blast furnaces, one in Granite City and four in South Chicago.

According to the American Iron and Steel Institute, Illinois produced 10.9 million short tons of steel in 1977, compared with 11.0 million short tons in 1976. Illinois ranked fourth in the production of raw steel in 1977.

Other Metals.—Smelter production of cadmium in Illinois in 1977 decreased 39.8% in quantity and 29.8% in value.

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[1] State Liaison Officer, Bureau of Mines, Springfield, Ill.

[2] Research assistant, Mineral Economics, Illinois Geological Survey.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
Allied Chemical Corp	Box 531 Cave In Rock, IL 62919	Plant	Hardin.
Pfizer, Inc	2001 Lynch Ave. East St. Louis, IL 62201	do	St. Clair.
Cement:			
Illinois Cement Co., Inc., subsidiary of Centex Corp.	Box 442 La Salle, IL 61301	do	La Salle.
Marquette Cement Manufacturing Co.	2200 First American Center Nashville, TN 37238	do	Do.
Medusa Corp	Box 5668 Cleveland, OH 44101	do	Lee.
Missouri Portland Cement Co	7751 Carondelet Ave. St. Louis, MO 63105	do	Massac.
Clay and shale:			
Absorbent Clay Products Co	Box 120 Alma, IL 62906	Pit and plant	Pulaski.
American Brick Co	6558 West Fullerton Ave. Chicago, IL 60635	do	Cook.
Diller Shale Products Co	Box 277 St. Elmo, IL 62458	Pits and plants	Fayette and Livingston.
Eastern Illinois Clay Co	499 South Chicago St. St. Anne, IL 60964	Pit and plant	Kankakee.
Illinois Cement Co., Inc., subsidiary of Centex Corp.	4600 Republic National Bank Tower Dallas, TX 75201	do	La Salle.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clay and shale —Continued			
Mt. Sterling Tile Co	Chatsworth, IL 60921	Pit and plant	Brown.
Marquette Cement Manufacturing Co.	2200 First American Center Nashville, TN 37238	do	La Salle.
Material Service Corp., subsidiary of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	do	Do.
Peoria Brick & Tile Co	Box 515 Peoria, IL 62675	do	Tazewell.
Richards Brick Co	234 Springer Ave. Edwardsville, IL 62025	do	Bond.
Ristokrat Clay Products Co	Box 4 Tonica, IL 61370	Pits and plants	La Salle.
Southern Clay Co., Inc., subsidiary of Lowe's Inc.	North Edward St. Cassopolis, MI 49031	Pit and plant	Pulaski.
Streator Brick Systems, Inc	West End of Ninth St. Streator, IL 61364	Pits and plants	La Salle and Livingston.
United States Gypsum Co. (A.P. Green Refractories)	101 South Wacker Dr. Chicago, IL 60606	Pit and plant	Grundy.
Valley View Dirt & Gravel Co	R.F.D. 1 Cornell, IL 61319	do	Livingston.
Western Stoneware Co	Box 288 Monmouth, IL 61462	do	McDonough.
Fluorspar:			
Allied Chemical Corp	Cave In Rock, IL 62919	Underground mines and mill.	Hardin.
Hastie Mining Co	Cave In Rock, IL 62919	Open pit	Do.
Ozark Mahoning Co	Box 57 Rosiclare, IL 62982	Underground mines, mill, and plant.	Do.
Gypsum:			
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	Mill	Lake.
Iron and steel:			
Interlake, Inc	310 South Michigan Ave. Chicago, IL 60604	Iron furnaces	Cook.
National Steel Corp., Granite City Steel Div.	Box 365 Granite City, IL 62040	Iron and steel furnaces.	Madison.
Republic Steel Corp	Box 6778 Cleveland, OH 44101	do	Cook.
United States Steel Corp	3426 East 89th St. Chicago, IL 60617	do	Do.
Wisconsin Steel Div. of Envirodyne.	410 North Michigan Ave. Chicago, IL 60611	do	Do.
Iron oxide pigments, finished:			
George B. Smith Chemical Works	Maple Park, IL 60151	Plant	Kane.
Pfizer, Inc	2001 Lynch Ave. East St. Louis, IL 62201	do	St. Clair.
Prince Manufacturing Co	Bowmanstown, PA 18030	do	Adams.
Solomon Grinding Service	Old Waterworks Road Springfield, IL 62702	do	Sangamon.
Lead and zinc:			
Allied Chemical Corp	Lambstown Rd. Cave In Rock, IL 62702	Underground mines and mill.	Hardin.
Ozark-Mahoning Co	Box 57 Rosicare, IL 62982	do	Do.
Lime:			
Marblehead Lime Co	300 West Washington St. Chicago, IL 60606	Kilns	Cook.
Vulcan Materials Co	Box 6 Countryside, IL 60102	do	Do.
Peat:			
Anderson Peat Co. of Illinois, a division of Fort Wayne Industries, Inc.	R.R. #3 Morrison, IL 61270	Bog and processing plant.	Whiteside.
Batavia Soil Builder, Inc	Nelson Lake Rd. Batavia, IL 60510	Processing plant	Kane.
Henry Frenzer, Inc	620 Webster St. Algonquin, IL 60102	do	Cook.
Joseph W. Grenus Excavating and Trucking.	1312 North Milwaukee Lake Villa, IL 60046	do	Lake.
Markman Peat Co	Route 3 Morrison, IL 61270	do	Whiteside.
Roots Peat Farm	122 North Beck Rd. Lake Villa, IL 60046	do	Lake.
Perlite, expanded:			
Filter Products Corp	124 North Buesching Rd. Lake Zurich, IL 60047	do	Do.
Johns-Manville Perlite Corp	Box 864 Joliet, IL 60434	do	Will.
Mica Pellets, Inc	1120 Oak Street De Kalb, IL 60115	do	De Kalb.
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	do	Lake.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Perlite, expanded —Continued			
Silbrico, Corp	6300 River Rd. La Grange, IL 60525	Processing plant	Cook.
Sand and gravel:			
Elmhurst-Chicago Stone Co	400 West 1st St. Elmhurst, IL 61026	Pits and plants	Du Page, Kane, Will.
General Dynamics Corp	300 West Washington St. Chicago, IL 60606	do	Cook, Du Page, Grundy, Kane, McHenry, Will.
McHenry Sand & Gravel Co., Inc	920 North Front St. McHenry, IL 60050	do	McHenry.
Martin Marietta Aggregates	Box 789 Cedar Rapids, IA	do	Ogle, Peoria, Tazewell, Woodford.
Meyer Aggregate	Box 56, Route 2 Algonquin, IL 60102	do	Kendall and McHenry.
Moline Consumers Co	313 16th St. Moline, IL 61265	do	La Salle, Pike, Rock Island.
Ottawa Silica Co	Box 577 Ottawa, IL 61350	do	La Salle.
Road Materials Corp., a division of E.M. Melahn Construction Co., Inc.	Box 391 East Dundee, IL 60118	do	Kane and McHenry.
Vulcan Materials Co	Box 391 La Grange, IL 60525	do	Kane, Lake, McHenry.
Wedron Silica Co., Del Monte Properties Co.	400 West Higging Rd. Park Ridge, IL 60068	Pit and plant	La Salle.
Smelters and refineries:			
AMAX Zinc Co., Inc	Box 347 East St. Louis, IL 62202	Zinc primary plant	St. Clair.
American Smelting & Refining Co	120 Broadway New York, NY 10005	do	Montgomery.
N. L. Industries, Inc	111 Broadway New York, NY 10006	Lead secondary plants.	Cook and Madison.
The Richardson Graphics Co	1800 South 54th Ave. Chicago, IL 60650	do	Cook.
Stone:			
American Smelting & Refining Co	120 Broadway New York, NY 10005	Quarry and plant	Union.
Anna Quarries, Inc	Box 180 Anna, IL 62906	do	Do.
Boughton Trucking & Materials, Inc.	R.R. #1 Plainfield, IL 60544	Quarry	Will.
Casper Stolle Quarry & Contracting Co.	Stolle Rd., R.R. 1 Dup, IL 62239	Quarries and plant	St. Clair.
Collinson Stone Co	3115 23d Ave. Moline, IL 61265	Quarry and plant	Rock Island.
Columbia Quarry Co	Box 1000 Dupo, IL 62239	Quarries and plant	Johnson, Massac, Pulaski, St. Clair.
Conco-Western Stone Co	111 North Spaulding St. Spring Valley, IL 61361	Quarry and plant	Kane.
Denny & Simpson Stone Co., Inc	Route 2 Harrisburg, IL 62946	do	Hardin.
East St. Louis Stone Co	7705 West Main St. Belleville, IL 62223	do	St. Clair.
Elmhurst-Chicago Stone Co	400 West 1st St. Elmhurst, IL 61026	do	Du Page.
Fox River Stone Co	Rt. 1 South Elgin, IL 60177	do	Kane.
General Dynamics Corp	300 West Washington St. Chicago, IL 60606	Underground mine, quarries, and plants.	Adams, Cook, Vermilion, Will.
Howard Arnold Construction Co	106 South 1st St. Fairbury, IL 61739	Quarry and plant	Livingston.
Hulcher Quarry, Inc	Box 25 Nokomis, IL 62075	do	Montgomery.
Illinois Cement Co., a division of Centex Corp.	Box 442 La Salle, IL 61301	do	La Salle.
Industrial Chemicals, a division of Allied Chemicals Corp.	Box 70 Morristown, NJ 07960	Quarries and plants	Randolph.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Kehobe Materials, Inc	Franklin Grove, IL 61031	Quarry and plant	Lee.
Lincoln Stone Quarry, Inc	Box 669 Hillside, IL 60162	do	Will.
Manteno Limestone Co	Box 668 Manteno, IL 60950	do	Kankakee.
Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, IL 60606	do	La Salle.
Medusa Cement Co., a division of Medusa Cement Corp.	Box 5668 Cleveland, OH 44101	Quarries and plants	Clark, Henderson, Kankakee, Lee, Livingston.
Mississippi Lime Co	7 Alby St., Box 247 Alton, IL 62002	Underground mine and plant.	Madison.
Missouri Portland Cement Co	7751 Carondelet Ave. St. Louis, MO 63105	Quarry and plant	Hardin.
Moline Consumers Co	313 16th St. Moline, IL 61255	Quarries and plants	Adams, Henry, La Salle, Pike, Rock Island, Schuyler, Warren.
Nokomis Quarry Co. of Illinois	Box C Nokomis, IL 62075	Quarry	Montgomery.
Pontiac Stone Co	Box 412 Pontiac, IL 61764	Quarries and plants	Livingston.
Rein, Schultz & Dahl, Inc	6217 Nesbitt Rd. Madison, WI 53711	do	Carroll, Stephenson, Winnebago.
Rigsby & Barnard Quarry, Inc	Box 56 Cave In Rock, IL 62919	Quarry and plant	Hardin.
Utica Stone Co	111 North Spaulding St. Spring Valley, IL 60525	do	La Salle.
Vulcan Materials Co	Box 391 LaGrange, IL 60525	Quarries and plant	Cook and Will.
Williams Stone Co	Box 426 Harrisburg, IL 62946	Quarry and plant	Hardin.
Sulfur, recovered:			
Marathon Oil Co	Robinson, IL 62454	Byproduct sulfur recovery.	Crawford.
Mobil Oil Corp	Box 874 Joliet, IL 60434	do	Will.
Natural Gas Pipeline Co. of America	122 South Michigan Ave. Chicago, IL 60603	do	Fayette and Kankakee.
Shell Oil Co	Box 262 Wood River, IL 62095	do	Madison.
Texaco, Inc	Box 52332 Houston, TX 77052	do	Lawrence and Will.
Union Oil Co. of California	1650 East Golf Rd. Schaumburg, IL 60196	do	Cook.
Tripoli, amorphous silica:			
Illinois Minerals Co	2035 Washington Cairo, IL 62914	Underground mine	Alexander.
Tammsco, Inc	Box J Tamms, IL 62988	do	Do.
Vermiculite, exfoliated:			
International Vermiculite Co	1st and Mound Sts. Girard, IL 62640	Plant	Macoupin.
Mica Pellets, Inc	1120 Oak St. De Kalb, IL 60115	do	De Kalb.
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	do	Du Page.

The Mineral Industry of Indiana

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Indiana Department of Natural Resources, for collecting information on all minerals except fuels.

By William S. Miska[1]

Indiana's mineral output in 1977 was valued at $697.6 million, 15% above the value of $606.4 million reported for mineral production in 1976. Of the $697.6 million total in 1977, bituminous coal accounted for 55%; petroleum, 9%; sand and gravel, 7%; crushed stone, 9%; and all remaining commodities combined, 19%.

Fuel production in Indiana has exceeded nonfuel mineral production in value since 1972. Output of coal, oil, and gas totaled $450.8 million in 1977. Increased drilling activity led to a rise in crude oil output in 1977, the first time production has increased since 1965.

Table 1.—Mineral production in Indiana[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Cement:				
Masonry ---------------- thousand short tons--	396	$14,270	W	W
Portland ------------------------do----	2,490	73,432	W	W
Clays ------------------------------do----	1,265	2,308	1,268	$2,237
Coal (bituminous) --------------------do----	25,369	312,990	27,797	384,493
Natural gas------------------ million cubic feet--	192	100	183	126
Peat -------------------- thousand short tons--	[r]66	[r]829	51	759
Petroleum (crude)-------- thousand 42-gallon barrels--	4,630	50,421	5,314	66,212
Sand and gravel -------------- thousand short tons--	25,884	45,521	26,248	50,089
Stone:				
Crushed--------------------------do----	28,187	59,418	26,740	61,392
Dimension ------------------------do----	263	12,787	244	11,804
Combined value of abrasives (natural), gypsum, lime, and items indicated by symbol W ------------------	XX	34,358	XX	120,446
Total -------------------------------	XX	[r]606,434	XX	697,558
Total 1967 constant dollars ------------------	XX	311,283	XX	[p]344,315

[p]Preliminary [r]Revised. W Withheld to avoid disclosing individual company proprietary data; included in "Combined value." XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Indiana, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	W	W	Stone, sand and gravel.
Allen	W	W	Stone, sand and gravel, peat.
Bartholomew	W	W	Stone, sand and gravel.
Blackford	W	W	Stone.
Boone	$330	W	Sand and gravel.
Carroll	W	W	Stone, sand and gravel.
Cass	W	W	Cement, stone, sand and gravel, clays.
Clark	W	W	Cement, stone, clays, sand and gravel.
Clay	W	$512	Clays.
Clinton	W	350	Sand and gravel.
Crawford	5,674	6,403	Stone.
Daviess	W	263	Sand and gravel.
Dearborn	510	W	Do.
Decatur	W	W	Stone.
De Kalb	600	1,142	Sand and gravel.
Delaware	W	W	Stone, sand and gravel.
Dubois	W	W	Clays.
Elkhart	815	1,352	Sand and gravel, stone.
Fayette	W	W	Sand and gravel.
Floyd	W	W	Do.
Fountain	W	W	Sand and gravel, clays.
Franklin	W	W	Sand and gravel, stone.
Fulton	251	W	Sand and gravel, peat.
Gibson	W	263	Sand and gravel.
Grant	W	W	Stone, sand and gravel, peat.
Greene	W	W	Sand and gravel, clays.
Hamilton	W	W	Sand and gravel, stone, peat.
Hancock	W	W	Peat, sand and gravel.
Harrison	W	W	Stone, sand and gravel.
Henry	1,028	876	Sand and gravel.
Howard	W	W	Sand and gravel, stone.
Huntington	W	W	Stone, sand and gravel, clays.
Jackson	W	W	Sand and gravel, clays.
Jasper	W	W	Sand and gravel, stone.
Jay	W	W	Stone, sand and gravel.
Jennings	W	W	Stone.
Johnson	382	368	Sand and gravel.
Knox	W	W	Do.
Kosciusko	1,012	1,197	Do.
Lagrange	W	W	Sand and gravel, stone.
Lake	43,815	W	Lime, cement, clays, stone.
La Porte	W	W	Sand and gravel, peat.
Lawrence	W	W	Cement, stone, clays.
Madison	W	W	Stone, sand and gravel.
Marion	W	W	Sand and gravel, stone.
Marshall	W	W	Sand and gravel, stone, peat.
Martin	W	W	Gypsum.
Miami	W	W	Stone, sand and gravel.
Monroe	W	W	Stone.
Montgomery	52	W	Sand and gravel, clays.
Morgan	W	W	Sand and gravel, clays, stone.
Newton	1,953	W	Stone.
Noble	370	476	Sand and gravel, stone.
Ohio	W	W	Sand and gravel.
Orange	1,432	W	Stone, abrasives.
Owen	W	W	Stone, sand and gravel.
Parke	W	W	Sand and gravel, clays.
Perry	W	W	Stone.
Pike	W	11	Sand and gravel.
Porter	W	W	Sand and gravel, clays.
Posey	W	W	Sand and gravel.
Pulaski	863	766	Stone, clays.
Putnam	W	24,992	Cement, stone, clays, sand and gravel.
Randolph	W	W	Stone, sand and gravel.
Ripley	W	W	Stone.
Rush	W	W	Stone, sand and gravel.
St. Joseph	W	1,908	Sand and gravel, peat, stone.
Scott	W	W	Stone.
Shelby	W	W	Stone, sand and gravel.
Spencer	W	--	
Starke	--	8	Sand and gravel.
Steuben	489	607	Sand and gravel, stone.
Sullivan	W	207	Do.
Switzerland	W	2,690	Do.
Tippecanoe	2,133	2,223	Sand and gravel.
Tipton	W	W	Do.
Union	--	9	Do.
Vanderburgh	W	W	Do.
Vermillion	W	W	Sand and gravel, clays.
Vigo	W	W	Sand and gravel, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Indiana, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Wabash	W	W	Stone, sand and gravel.
Warren	$2,479	$1,322	Sand and gravel.
Warrick	W	--	
Washington	W	W	Stone.
Wayne	1,639	1,633	Sand and gravel, stone.
Wells	W	W	Stone, peat.
White	727	819	Stone.
Whitley	W	W	Sand and gravel.
Undistributed[2]	r539,880	647,161	
Total	r606,434	697,558	

r Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Benton, Brown, Hendricks, and Jefferson.

[2] Includes coal (bituminous), petroleum, and natural gas production that cannot be assigned to specific counties, and values indicated by symbol W.

Table 3.—Indicators of Indiana business activity

		1976	1977p	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,433.0	2,459.0	+1.1
Unemployment	do.	148.0	141.0	-4.7
Employment (nonagricultural):				
Mining	do.	8.2	8.3	+1.2
Manufacturing	do.	685.1	707.4	+3.2
Contract construction	do.	82.0	87.8	+7.1
Transportation and public utilities	do.	102.6	104.9	+2.2
Wholesale and retail trade	do.	437.3	454.0	+3.8
Finance, insurance, real estate	do.	91.0	92.5	+1.6
Services	do.	285.0	293.1	+2.8
Government	do.	332.5	341.5	+2.7
Total nonagricultural employment	do.	2,023.7	2,089.5	+3.2
Personal income:				
Total	millions	$33,254	$36,890	+10.9
Per capita		$6,259	$6,921	+10.6
Construction activity:				
Number of private and public residential units authorized		30,677	38,178	+24.5
Value of nonresidential construction	millions	$346.1	$425.8	+23.0
Value of State road contract awards	do.	$130.2	$137.0	+5.2
Shipments of portland and masonry cement to and within the State	thousand short tons	1,816	1,806	-.6
Mineral production value:				
Total crude mineral value	millions	r$606.4	$697.6	+15.0
Value per capita, resident population		r$114	$130	+14.0
Value per square mile		r$16,710	$19,221	+15.0

p Preliminary. r Revised.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Legislation and Government Programs.—Public Law 149 became effective in May 1977, establishing higher bonds and fees on surface coal mines. The law increased reclamation bonds from $600 per acre to a minimum of $1,000 per acre, with the Natural Resources Commission being allowed to require a bond of up to $5,000 per acre. Fees were increased to $100 and $50 for each acre mined. The old fee rate was $50 and $30 for each acre mined. The law also requires operators to pay a new $2,000 fee each year to maintain a fund for reclaiming land stripped for coal that mining companies failed to reclaim.

Bills that failed to pass in the legislature included a measure authorizing counties to regulate strip mining, and another placing a 50-cent-per-ton severance tax on coal to finance coal-related energy projects and reclaim abandoned mine lands.

The Division of Reclamation, with approval of the Natural Resources Commission, issued 200 surface mining permits for coal, clay, and shale extraction, 71 more than the 129 permits issued in 1976. The number of companies receiving permits increased from 66 in 1976 to about 85 in 1977. Acreage under permit totaled 8,151, a 28% increase over the 6,382 acres under permit in 1976. The permits issued in 1977 require reclamation of the land for the following uses: 562 acres (including acreage for wildlife and other uses) or 7%, forest land with a maximum grade of 33-1/3%; 937 acres or 11%, range land with the same maximum grade; 3,479 acres or 43%, pasture land with a maximum grade of 25%; and 3,173 acres or 39%, row crop land with a maximum grade of 8%. A principal trend in mine land reclamation in Indiana during the past 5 years has been the increase in land reclaimed for row crop use. In 1972, row crop use represented only 9% (409 acres) of the total mine land reclaimed (4,410 acres), compared with 39% in 1977.

The Indiana Geological Survey published Bulletin 55, "Reduction of Sulfur in Indiana Coal by Washability Techniques," and Special Report 12, "Environmental Geology of the Evansville Area, Southwestern Indiana." Among other publications released by the Indiana Geological Survey were a "Map of Southwestern Indiana Showing Locations of Active Coal Mines" and a "Directory of Crushed Stone, Ground Limestone, Cement, and Lime Producers in Indiana."

The Federal Bureau of Mines conducted surface coal mine blasting-monitoring research in Indiana in cooperation with AMAX Coal Co. The research is aimed at gathering data on blasting and its effects, which will be useful to industry and Government in implementation of Federal blasting controls required by the Surface Mining Control and Reclamation Act of 1977. The Bureau of Mines also conducted research on the recovery of metal from stainless steel wastes in a joint effort with Joslyn Stainless Steel Co. of Fort Wayne. The firm successfully recovered chromium, nickel, molybdenum, and iron from wastes in a commercial arc furnace, using a refining technique developed by the Bureau.

Federal mine inspectors from the Mine Safety and Health Administration in the Department of Labor (formerly Mining Enforcement and Safety Administration in the Department of the Interior) conducted 484 regular safety and health inspections and 619 spot inspections at Indiana clay, cement, gypsum, peat, sand and gravel, and stone operations. During these inspections, the inspectors issued 3,401 notices of violation of mandatory standards and 41 closure orders for noncompliance with notices and occurrences of situations of imminent danger. After the operators eliminated the hazards, 3,393 notices and 42 closure orders were abated. Federal coal mine inspectors conducted 154 regular inspections, 141 spot inspections, 54 electrical inspections, and 45 technical inspections at Indiana coal mines.

State mine inspectors from the Indiana Bureau of Mines and Mining conducted 74 health and safety inspections and 8 spot inspections at active and abandoned coal mines and coal-loading docks. The State agency also inspected the two underground gypsum mines in Martin County.

Employment and Injuries.—Employment in mining activities ranged from 6,800 persons in January to a high of 8,500 persons during the July-to-September period and a low of 4,900 in December. The drop in December resulted from the seasonal shutdown of quarries and pits during the winter months and from the shutdown of coal mines during the national coal strike, which idled most Indiana coal mines until April 1978. Average employment for the year was 7,700 persons, nearly half were engaged in coal mining activities, and the remainder in the production of industrial minerals, oil, and gas. Miners' wages have increased an average of 63% since 1973, reaching $340 per week during 1977. The total mining industry annual payroll is about $136 million.

Injuries in coal mining operations included 1 fatality, 87 nonfatal disabling injuries, and 153 nondisabling injuries for a total of 241 injuries, compared with 298 injuries (including 1 fatality) during 1976. Nonmetallic mineral producers reported 121 injuries, including 1 fatality, 81 nonfatal disabling injuries, and 39 nondisabling injuries. During 1976, nonmetallic mineral producers reported 125 injuries, including 2 fatalities.

United States Gypsum Co.'s underground gypsum mine near Shoals in Martin County was a winner in the 1977 Sentinels of Safety awards program cosponsored by the Mine Safety and Health Administration and the American Mining Congress. The Shoals mine had the best safety record in the Nation for underground nonmetal mines; 66,389 employee hours of exposure without a disabling work injury.

American Aggregates Corp.'s Carmel plant in Hamilton County was the winner of the National Sand and Gravel Association's 1977 safety contest class F competition for plants producing less than 60,000 tons. Another 14 Indiana sand and gravel operations received certificates of achievement in safety for accident-free records during 1977.

Special safety certificates were awarded by the National Limestone Institute Inc. to Kixmiller Bros., Inc., Freelandville quarry, for 7 consecutive years without a disabling injury; Mill Creek Stone and Gravel Corp., Rich Valley quarry, and Western Materials Co., Francesville quarry, for 6 consecutive years without a disabling injury; and Mulzer Crushed Stone Co., Mitchell quarry, for 4 years without a disabling injury. Thirty-five other Indiana quarries were cited by National Limestone for accident-free operations during 1977.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives.—Hindostan Whetstone Co., Indiana's only producer of natural abrasives, fabricated manicure stones from sandstone quarried near Orleans in Orange County. The firm is one of the oldest manufacturing establishments in Indiana, dating back to 1821. Output declined in quantity but remained nearly the same in value as in 1976. Among the 10 States producing natural abrasives during 1977, Indiana ranked 10th in quantity and 9th in value.

Cement.—Portland cement shipments, comprising 85% of Indiana's cement output, decreased in quantity and value compared with 1976 figures. Portland cement was produced at five plants, three of which also produced masonry cement. Masonry cement shipments increased in both quantity and value. The average mill value of portland cement increased $1.17 per ton to $30.66 and masonry cement increased $1.21 per ton to $37.25.

Type I (general construction use) and Type II (moderately low heat and moderate degree of resistance to sulfate attack) comprised 92% of the portland cement shipments; 7% was Type III (high-early-strength); and all others combined comprised 1%.

Disposition of portland cement shipped by Indiana manufacturers was as follows: 66% to ready-mix companies; 17% to concrete product manufacturers for concrete blocks, concrete pipes, precast prestressed concrete, and other concrete products; 7% to building material dealers; 6% to highway contractors; and the remaining, 4% to other contractors, government agencies, and miscellaneous uses.

Apparent consumption of portland cement in Indiana during 1977 was 1,684,000 tons, slightly less than the 1,700,000 tons consumed in 1976. Apparent consumption of masonry cement increased slightly from 116,000 tons in 1976 to 122,000 tons in 1977.

Late in the year, Lehigh Portland Cement Co., with a plant at Mitchell in Lawrence County, became a wholly owned subsidiary of Heidelburg Cement, a West Germany firm.

Louisville Cement Co. completed a $23 million expansion at its Speed plant in Clark County. The plant's new kiln has a greater capacity than the three old kilns which it replaced, and it uses 30% less energy to produce a ton of cement. The firm's Logansport plant in Cass County encountered an unusual and costly problem, when loss of electrical power during a storm and failure of a backup generator to keep heated kilns revolving resulted in warpage of the steel shell on one of the kilns.

Clays.—Indiana's production of clay was nearly the same as in 1976. Output totaled 1,268,000 tons valued at $2,237,000, compared with 1,265,000 tons valued at $2,308,000 in 1976. Common clay and shale accounted for more than 99% of the total output; the remainder was fire clay. Clay and shale were produced by 21 companies with 26 mines in 17 counties. Five companies with six mines produced 56% of the State's clay: Louisville Cement Co. in Cass and Clark Counties; Hydraulic-Press Brick Co. in Morgan County; Lone Star Industries, Inc., in Putnam County; C & F Shale Co. in Clay County; and American Brick Co. in Lake County.

Half of Indiana's clay was produced in two counties: Clay County with 350,000 tons valued at $512,000, and Morgan County with 286,000 tons valued at $430,000. Together, Clay and Morgan Counties accounted for 50% of the total tonnage and 42% of the total value. Other important clay-producing counties included Clark, Lake, Lawrence, and Putnam.

About 45% of all production was used in cement manufacturing, 36% in brick manufacturing, 3% in sewer pipe, 2% in structural tile, and the remaining 14% in lightweight aggregate, drain tile, flower pots and other pottery, ceramic tile, firebrick, and various other clay and shale products.

General Shale Products Corp. began installation of the firm's patented coal-firing system at the Mooresville plant in Morgan County. The system, designed for brick tunnel kilns, is expected to be operational at the Indiana plant by June 1978.

Local, State, and Federal air pollution control agencies took action against American Brick Co.'s brick plant at Munster in Lake County. The common or "backing" brick made at the plant results in air particulate emissions during the kiln drying process. The brickmaking operation dates from 1896 and employs 115 workers. Company officials vowed to fight the matter in court, contending that the pollution control equipment suggested by air pollution control authorities are beyond the economic means of the company.

A new firm, Yellow Banks Clay Co., began producing clay for the manufacture of pottery near Selvin in Warrick County.

Table 4.—Indiana: Clays sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1973	[2]43	[2]174	1,393	2,394	1,436	2,568
1974	26	118	1,066	1,828	1,092	1,947
1975	2	16	1,092	1,945	1,094	1,961
1976	2	21	1,263	2,288	1,265	2,308
1977	1	20	1,266	2,216	1,268	2,237

[1] Data may not add to totals shown because of independent rounding.
[2] Includes a small amount of kaolin.

Fluorspar.—National Briquet Corp. fabricated fluorspar briquets at its East Chicago plant in Lake County from fluorspar ore imported from foreign and domestic sources. The briquets are sold primarily to iron and steel producers. The plant has been in operation since 1971.

Gypsum.—Crude gypsum production increased 8% in quantity and 12% in value over that of 1976. Output came from two underground mines near Shoals in Martin County, operated by National Gypsum Co. and United States Gypsum Co. Some raw gypsum was sold for use in the manufacture of cement. The remainder was calcined at plants adjacent to the mines. United States Gypsum Co. also calcined gypsum imported from Michigan by lake carrier at a plant near East Chicago in Lake County. Calcined gypsum production declined slightly. Most of the calcined gypsum was used in the manufacture of wallboard and sheathing for the building construction industry.

Miles Laboratories, Inc., processed and marketed byproduct gypsum produced chemically in the manufacture of citric acid. Output and value of byproduct gypsum in 1977 increased sharply compared with the 1976 figures.

United States Gypsum Co. announced plans for a 25% expansion of its wallboard production plant at Shoals. When completed by August 1978, it is expected to be the largest such facility in the Nation.

Lime.—Production at Indiana's two lime plants decreased 2% in quantity and 10% in value. Marblehead Lime Co. produced quicklime at Buffington, Lake County, and Inland Steel Co. produced quicklime at its Indiana Harbor Works, also in Lake County. The Buffington plant ranked third in the Nation in lime output, and the Inland Steel Co. plant ranked 10th. At both plants the lime is produced from limestone transported from quarries in Michigan by lake freighters. Lime consumption in Indiana during 1977 totaled 1,865,000 tons, 6% less than in 1976. Indiana ranked fourth in lime consumption after Ohio, Pennsylvania, and Michigan. Most of the lime was used by the steel industry in steelmaking furnaces.

Peat.—Peat sales totaled 51,000 tons valued at $759,000, compared with 1976 sales of 66,000 tons valued at $829,000. The average value of all peat sold was $15.00 per ton, a $2.40 per ton increase over that of 1976. Eleven companies produced peat moss and reed-sedge in nine counties: Allen, Fulton, Grant, Hamilton, Hancock, Marshall, St. Joseph, La Porte, and Wells. The largest producers were Millburn Peat Co., Inc., near La Porte in La Porte County and Organic Products Co. near Noblesville in Hamilton County. About two-thirds of the peat was packaged, and the remainder was sold in bulk form. Most of the peat was used for soil conditioning and horticultural use. Indiana ranked fourth in peat output during 1977, after Michigan, Florida, and Illinois.

The Iroquois Peat Moss, Inc., peat mine near Rensselaer in Jasper County was purchased by Michigan Peat, Inc., one of the largest producers of peat in the Nation. Michigan Peat, Inc., reopened the mine in 1978. It had been idle since 1976.

Perlite (Expanded).—Sales of expanded perlite totaled 19,757 tons valued at $1,828,000, increases of 31% in quantity and 49% in value over the 1976 figures. Average value per ton jumped $11.25 to $92.53, a 14% increase. Crude perlite was shipped to Indiana from mines in New Mexico for processing to expanded perlite at six plants by United States Gypsum Co. at its plants in Lake and Martin Counties, National Gypsum Co. in Martin County, Grefco, Inc., in Montgomery County, Chemrock Corp. in Tippecanoe County, and Johns-Manville Corp. in Madison County. This is the first year that expanded perlite production was reported in Madison County. The principal uses for perlite in Indiana were for plaster aggregate, filter aid, insulation, and acoustic tile.

Sand and Gravel.—Sand and gravel production in Indiana totaled 26,248,000 tons valued at $50,089,000, increases of 1% in quantity and 10% in value over 1976 figures. The average unit value increased 15 cents per ton to $1.91. Both construction sand and gravel and industrial sand were produced.

Construction sand and gravel accounted for 99% of the total output and 98% of the total value of output. Of the 25.9 million tons of construction sand and gravel produced, 51% or 13.2 million tons was gravel valued at $26.8 million, and 49% or 12.7 million tons was sand valued at $22.1 million. The average unit value of construction gravel was $2.04 per ton. Construction sand averaged $1.73 per ton. Compared with the 1976 values, the average value of construction gravel decreased 3 cents per ton and the average value of construction sand increased 29 cents per ton.

Industrial sand totaled 341,000 tons and accounted for 1% of the total output and 2% of the total value. The average unit value of industrial sand was $3.54 per ton, compared with $3.21 per ton in 1976. No industrial gravel was reported.

The principal uses for construction sand and gravel were as follows: 41% for concrete aggregate, 23% for asphaltic concrete and other bituminous mixtures, 15% for roadbase and coverings, 14% for fill, and 6% for concrete products. Most of the industrial sand was used in making moldings and as a furnace sand.

Nationally, Indiana ranked 10th in the output of sand and gravel, accounting for nearly 3% of the 929,200,000 tons produced in the United States during 1977.

Sand and gravel was mined at 201 locations in 69 counties by 185 companies. Marion County was the leading producer with 2.5 million tons, followed by Hamilton with 1.5 million tons, Switzerland with 1.4 million tons, and St. Joseph and Tippecanoe with 1.1 million tons each. Four mines produced 700,000 tons or more each; 8, between 400,000 and 700,000 tons each; 26, between 200,000 and 400,000 tons each; 55, between 100,000 and 200,000 tons each; 41, between 50,000 and 100,000 tons each; and 67, less than 50,000 tons each, of which 43 produced less than 25,000 tons each. Western Materials Co; Martin Marietta Corp., Central Div.; and American Aggregates Corp. were the leading producers.

Table 5.—Indiana: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	10,401	19,436	10,595	22,675
Concrete products (cement blocks, bricks, pipe, etc.)	2,401	4,256	1,504	3,145
Asphaltic concrete aggregates and other bituminous mixtures	5,376	10,143	5,883	11,641
Roadbase and coverings	3,574	5,788	3,786	6,391
Fill	3,190	3,918	3,642	4,171
Other uses	576	808	496	857
Total[1]	25,518	44,348	25,907	48,881

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Indiana: Sand and gravel sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams	2	W	W	3	244	437
Allen	8	674	1,068	11	974	1,617
Bartholomew	2	W	W	2	W	529
Blackford	1	4	4	--	--	--
Boone	3	188	330	2	W	W
Cass	3	323	578	2	279	555
Clark	2	124	224	1	150	263
Clinton	1	W	W	1	200	350
Daviess	1	W	W	1	150	263
De Kalb	6	414	600	7	663	1,142
Delaware	2	W	W	4	383	578
Elkhart	9	548	806	7	798	1,342
Fountain	3	742	1,433	4	604	1,201
Gibson	1	W	W	1	150	263
Grant	3	366	679	3	489	1,014
Hamilton	4	1,522	3,163	5	1,490	3,591
Hancock	3	167	372	3	182	335
Henry	4	527	1,028	4	448	876
Johnson	3	228	382	2	200	368
Kosciusko	6	796	1,012	6	741	1,197
Lagrange	6	155	213	5	324	542
La Porte	3	497	1,228	4	748	1,883
Madison	7	503	801	5	441	795
Marion	6	2,391	4,373	7	2,474	5,038
Marshall	2	292	544	2	W	W
Miami	3	656	1,475	3	240	508
Montgomery	3	48	19	2	W	W
Morgan	8	943	1,531	8	702	1,341
Noble	7	236	365	5	296	471
Parke	2	W	W	3	292	548
Pike	1	5	15	1	5	11
Putnam	3	71	110	2	W	W
Randolph	3	W	W	3	153	255
Rush	2	18	23	2	27	37
St. Joseph	8	1,018	1,457	8	1,145	1,907
Shelby	4	486	835	4	413	749
Starke	--	--	--	1	7	8
Steuben	5	414	482	4	361	603
Sullivan	3	204	377	3	92	151
Switzerland	1	W	W	1	1,425	2,550
Tippecanoe	4	1,268	2,133	5	1,099	2,223
Union	--	--	--	1	5	9
Vermillion	4	501	904	5	477	900
Vigo	6	389	661	5	287	599
Wabash	2	W	W	2	55	74
Warren	5	1,044	2,479	5	595	1,322
Wayne	4	513	1,026	3	499	1,057
Other counties[1]	35	7,611	12,792	33	5,941	10,587
Total[2]	204	25,884	45,521	201	26,248	50,089

W Withheld to avoid company proprietary data; included with "Other counties."

[1] Includes Carroll, Dearborn, Fayette, Floyd, Franklin, Fulton, Greene, Harrison, Howard, Huntington, Jackson, Jasper, Jay, Knox, Lake (1976), Ohio, Owen, Porter, Posey, Spencer (1976), Tipton, Vanderburgh, and Whitley.

[2] Data may not add to totals shown because of independent rounding.

Stone.—Stone production totaled 26,985,000 tons valued at $73,196,000, a decrease of 5% in quantity but an increase of 1% in value. Seventy-one companies operated 121 quarries in 50 counties. Stone output in 1977 was as follows: Crushed and broken stone, 26,740,000 tons with a value of $61,392,000; dimension stone, 244,000 tons with a value of $11,804,000; and marl, 17,000 tons with a value of $26,000. The average value of crushed and broken stone increased 19 cents per ton to $2.30 per ton. The average value of dimension stone decreased 24 cents to $48.38 per ton. Marl decreased 11 cents per ton to an average value of $1.56 per ton.

Indiana led the Nation in the output of dimension stone, most of which was dimension limestone produced in Monroe and Lawrence Counties. Leading producers were Victor Oolitic Stone Co., Indiana Limestone Co., Inc., and B. G. Hoadley Quarries, Inc. A total of 17 companies produced dimension stone at 20 limestone and dolomite quarries and 1 sandstone quarry. Output decreased 7% in quantity and 8% in value from that of 1976.

Table 7.—Indiana: Stone sold or used by producers, by use

(Thousand short tons and thousand dollars unless otherwise specified)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dimension:[1]				
Rough architectural thousand cubic feet	1,668	3,367	1,783	3,796
Irregular-shaped stone do.	135	256	99	165
Rough flagging do.	113	106	96	107
Cut stone do.	404	5,010	338	4,301
Sawed stone do.	606	2,864	476	2,402
House stone veneer do.	425	1,019	340	921
Other uses[2] do.	243	165	185	111
Total[3] thousand short tons	263	12,787	244	11,804
Crushed and broken:[4]				
Bituminous aggregate	2,637	5,960	2,592	6,066
Concrete aggregate	3,789	8,340	3,832	9,331
Dense-graded roadbase stone	4,957	10,820	4,779	10,907
Macadam aggregate	2,145	4,668	1,513	3,645
Surface treatment aggregate	1,877	4,106	961	2,447
Roadstone	5,004	10,300	6,662	15,506
Agricultural limestone	3,324	7,231	2,090	4,908
Cement manufacture	3,161	4,012	3,159	5,019
Railroad ballast	379	732	248	485
Riprap and jetty stone	294	842	301	903
Sulfur dioxide removal	W	W	69	187
Flux stone	19	43	W	W
Soil conditioners	W	W	18	33
Other uses[5]	600	2,366	517	1,955
Total[3]	28,187	59,418	26,740	61,392
Grand total[3]	28,450	72,205	26,985	73,196

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone and sandstone.

[2] Includes stone used for rubble, dressed flagging, dressed construction stone, and other rough stone.

[3] Data may not add to totals shown because of independent rounding.

[4] Includes limestone and marl.

[5] Includes stone used for glass manufacture, mineral food, filter stone, asphalt filler, fill, mine dusting, unspecified uses, and uses indicated by symbol W.

Crushed and broken stone was produced by 53 companies at 95 quarries. Output decreased 5% in quantity and increased 3% in value. Leading producers were Mulzer Crushed Stone Co., France Stone Co., Ralph Rogers & Co., Inc., and Irving Bros. Gravel Co., Inc. Among the States, Indiana ranked 16th in the output of crushed stone, accounting for nearly 3% of the national output.

Crawford County was the State's leading producer of crushed limestone with 2.8 million tons, followed by Clark County with 2.7 million tons, Putnam County with 2.6 million tons, and Allen County with 2.2 million tons. Lawrence, Hamilton, Crawford, and Cass Counties produced more than 1 million tons each. Together these seven counties accounted for 14.4 million tons, or 54% of Indiana's 1977 output of crushed limestone.

Marl was produced by seven companies at nine pits in Elkhart, Lagrange, Noble, and Steuben Counties. Output decreased 31% in quantity and 35% in value.

Three of Indiana's 121 quarries had an output exceeding 900,000 tons each; 9, between 500,000 and 900,000 tons each; 60, between 100,000 and 500,000 tons each; and 49, less than 100,000 tons each, of which 32 produced less than 25,000 tons each.

Principal uses for Indiana's stone output were as follows: 61% of total stone tonnage for roadbase and paving materials; 14% for concrete aggregate; 12% for concrete manufacture; 8% for agricultural purposes; 1% for riprap and jetty stone; 1% for railroad ballast; and 3% for rough and dressed architectural dimension stone and miscellaneous chemical and industrial uses. About 92% of the stone was transported by truck, 6% by water, and 2% by railroad.

A new chemical use for limestone produced in Indiana began when Indianapolis Power and Light Co. commenced stockpiling limestone at its coal-burning powerplant near Petersburg. The stone was quarried by Western Materials Co., a division of Medusa Corp., at Orleans and transported to Petersburg by truck. It will be used in a scrubber, expected to be operational by mid-1978, to control sulfur emissions from coal-burning boilers.

Erie Stone, Inc., commenced deepening its quarry in Huntington County. In recent years, a number of stone producers have chosen to deepen their quarries rather than obtain land to open new quarries. The trend toward deepening quarries results in fewer new quarries being opened and may be in response to the increased capital costs incurred by quarry operations opened in recent years. Where it is impossible to deepen a quarry, some firms are considering converting their operations to underground mines to gain access to stone reserves and to avoid a costly move to a new quarry location.

The major stockholder in Indiana Limestone Co., one of the State's largest dimension stone producers, granted an option to an unnamed party to buy his stock in the company for $9 per share. There are 566,000 shares of stock in the company, of which the major stockholder owns 70%.

Sulfur.—Sulfur was recovered from crude petroleum at refineries operated by American Oil Co. and Energy Cooperative, Inc., in Lake County. Sales decreased 6% in quantity and 8% in value.

Table 8.—Indiana: Crushed limestone sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976		1977	
	Quantity	Value	Quantity	Value
Allen	1,818	3,767	2,182	5,185
Cass	1,026	1,668	1,082	1,918
Clark	2,770	4,977	2,712	5,254
Crawford	2,914	5,674	2,890	6,408
Elkhart	--	--	7	10
Hamilton	1,273	2,970	1,316	3,325
Harrison	542	1,170	422	859
Lake	--	--	25	114
Lawrence	1,991	3,778	1,619	3,474
Noble	--	--	6	5
Orange	631	1,382	542	1,288
Pulaski	390	850	320	760
Putnam	2,752	5,808	2,638	6,184
St. Joseph	--	--	W	1
Steuben	--	--	1	4
Sullivan	21	102	12	56
Switzerland	W	136	W	140
Washington	215	W	W	W
Wayne	222	613	208	576
White	309	727	327	819
Undistributed[1]	11,289	25,756	10,415	25,051
Total	28,163	59,378	26,724	61,366

W Withheld to avoid disclosing company proprietary data; included in "Undistributed."

[1] Includes Adams, Bartholomew, Blackford, Carroll, Decatur, Delaware, Grant, Howard, Huntington, Jasper, Jennings, Lagrange (1977), Madison, Marion, Marshall (1977), Miami, Monroe, Morgan, Newton, Owen, Perry, Randolph, Ripley, Rush, Scott, Shelby, Vigo, Wabash, and Wells.

Table 9.—Indiana: Crushed calcareous marl sold or used by producers

Year	Number of producers	Short tons	Value
1973	10	41,241	$48,981
1974	10	48,602	62,215
1975	9	28,373	40,845
1976	7	23,972	39,973
1977	7	16,581	25,901

METALS

Aluminum.—The Aluminum Company of America (Alcoa) produced aluminum ingots and thin-gage aluminum sheet at its smelter and fabricating plant in Warrick County near Evansville. The smelter, with 6 potlines of 150 pots each, is capable of producing 290,000 tons annually of aluminum from aluminum oxide or alumina. Alumina was supplied to the Warrick smelter via river barge from Alcoa plants at Mobile, Ala., Point Comfort, Tex., and Clarendon Parish, Jamaica.

Aluminum ingot production decreased about 23% in quantity and 10% in value in 1977 because severe cold weather in January knocked out part of the company's electric powerplant and forced shutdown of three of the six potlines and a layoff of 190 workers. The first potline did not resume production until March. The second potline was restarted in June, and half of the third potline was restarted during the fall. Continued electric supply problems kept the other half of the third potline shut down during the remainder of the year. Aluminum scrap and cans recycling totaled 48.2 million pounds during 1977, up 1.2 million pounds from that of 1976.

Employment at the plant reached an alltime high of 3,452 persons during December, an increase of 177 during the year. A new 3-year labor agreement went into effect at the end of May, bringing the average employee wage up to about $17,000 per year.

Apex International Alloys, Inc., announced plans to spend $5.5 million to convert a plant site near Bicknell in Knox County to an aluminum dross processing plant to recover aluminum metal. The plant is expected to employ 93 persons and be in operation early in 1978.

Pig Iron and Steel.—Pig iron production was 16,490,000 tons in 1977, a decrease of 49,000 tons, or 5%. Indiana continued to rank second in the Nation in pig iron production, after Pennsylvania. Pig iron shipments totaled 16,585,000 tons valued at about $3 billion; 1976 shipments were 17,461,000 tons. Pig iron was produced in blast furnaces: 18 were in operation at the end of January, 22 (maximum for the year) at the end of April, and 21 at the end of December.

Inland Steel Co., United States Steel Corp., and Youngstown Sheet & Tube Co. each produced pig iron and steel in Lake County, and Bethlehem Steel Corp. produced pig iron and steel in Porter County.

Steel preduction reported by the American Iron and Steel Institute was 21,470,000 tons, 3% or 708,000 tons less than Indiana's 1976 output of 22,178,000 tons. Indiana ranked second in steel production, following Pennsylvania. Steel was produced in basic oxygen furnace shops by each of the four primary preducers and in open-hearth furnaces by Inland Steel Co. and Youngstown Sheet & Tube Co. Steel was also produced from scrap in electric furnaces.

Inland Steel Co. placed a new precipitator system in operation to control dust emissions at its No. 4 A.C. station — a coal-burning powerplant. The system increased the dust cleaning efficiency from the previous capability of 85% to more than 99%. The firm's expenditures for air and water pollution equipment totaled $46.1 million in 1977, bringing the 1973-77 investment to $153.1 million. Annual operating and maintenance costs for pollution control increased 18%, totaling $24.6 million compared with $20.9 million in 1976. The opening of a new coal mine in Illinois during 1978 will bring Inland Steel Co. closer to its goal of self-sufficiency in required raw materials for its Indiana plant. During 1977, the firm acquired 88% of its iron ore from mines wholly owned or partly owned by subsidiary firms, as well as 74% of its metallurgical coal needs and all of its limestone requirements. About 67% of the iron ore and limestone shipped to the Indiana Harbor Works was carried by Inland's fleet of six bulk vessels. About 51% of the 1977 coal requirements were transported in the firm's own rail hopper cars. An additional 300 cars were acquired in 1977 to service the new coal mine in Illinois at McLeansboro.

Bethlehem Steel Corp. started up a new 110-inch plate mill at its Burns Harbor Works early in 1978. This mill, combined with the existing 160-inch mill, provides Burns Harbor with the largest plate capacity of any steel plant in the country. Construction of a third 300-ton-capacity basic oxygen furnace neared completion. The $17 million system was expected to be operational during the first quarter of 1978. During July 1977, the plant set a North American blast furnace production record when furnace D produced 194,631 net tons, averaging 6,278 tons per day. Another industry record was set by the plant during October when the twin-strand casting machine produced 131,061 tons of slabs. Continuous casting converts molten steel directly into slabs, eliminating several time-consuming steps required by the traditional steel-to-ingot-to-slab method.

U.S. Steel Corp. completed rehabilitation of the coke battery and initiated operation of a facility for the preduction of one-side-electrogalvanized sheet at its Gary Works. The new product was developed by U.S. Steel research for use primarily on exterior automotive body panels.

In September, Youngstown Sheet & Tube Co. announced the adoption of a plan to concentrate a major portion of its steel production at its Indiana Harbor Works and the discontinuance of production of certain steel products in the Youngstown, Ohio, area. The plan also would entail a move of company headquarters from Youngstown to Chicago. A merger of the parent firm, Lykes Corp., with the LTV Corp. was announced early in November. By mid-October, Youngstown Sheet & Tube Co. was midway through a rebuilding program for 21 annealing furnaces at the Indiana plant. The new direct-line furnaces are expected to increase productivity of the units by 20% and reduce the amount of fuel required during the heat-treating process by about 30%. The rebuilding takes about 45 days at a cost of $100,000 per furnace.

Slag Iron and Steel.—Slag sold or used by Indiana processors totaled 3,665,000 tons valued at $7,886,000. Iron slag produced in blast furnaces comprised 3,421,000 tons, or 93% of the total tonnage, and $7,472,000, or 95% of the total value. The remainder was steel slag produced in steelmaking furnaces.

The principal uses for the slag were as follows: 37%, roadbase; 20%, railroad ballast; 9%, fill; 7%, asphaltic concrete and other bituminous mixtures; 6%, concrete aggregate; and 21%, expanded iron slag as lightweight concrete aggregate, as mineral wool, for concrete manufacture, and for other applications.

Other Metals.—Federated Metals, a subsidiary of ASARCO Incorporated expanded its plant at Whiting with the relocation of zinc anode and copper anode manufacturing lines from plants in Texas and New Jersey. The plant already is a major producer of brass, tin, and tin-lead anodes. Anodes are used in metal-plating processes.

USS Lead Refinery, Inc., a division of UV Industries, Inc., recovered antimonial lead and lead alloying elements at its secondary refinery in Lake County.

M. K. Metals, a processor of scrap metals, began operations at Atwood in Kosciusko County. The firm uses a new process to reclaim and upgrade nonferrous metals such as copper and other products, that are difficult to process by traditional methods. The product is a metal pellet suitable for remelting by metal-smelting firms.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive Stone: Hindostan Whetstone Co	Box 432 Bedford, IN 47421	Quarry and plant	Orange.
Cement:			
Lehigh Portland Cement Co.[1]	718 Hamilton St. Allentown, PA 18105	Plant	Lawrence.
Lone Star Industries, Inc.[1] [2]	One Greenwich Plaza Greenwich, CT 06830	do	Putnam.
Louisville Cement Co.[1] [2]	501 South 2nd St. Louisville, KY 40202	do	Cass and Clark.
United States Steel Corp	600 Grant St. Pittsburgh, PA 15230	do	Lake.
Clays:			
American Brick Co	6558 West Fullerton Ave. Chicago, IL 60635	Pit, plant	Do.
C & F Shale Co	203 South Walnut St. Brazil, IN 47834	do	Clay.
General Shale Products Corp	Box 86 Mooresville, IN 46158	do	Morgan.
Hydraulic-Press Brick Co	705 Olive St. St. Louis, MO 63101	do	Do.
Log Cabin Coal Co	304 South Depot St. Brazil, IN 47834	Pits	Clay.
Gypsum:			
National Gypsum Co.[3]	325 Delaware Ave. Buffalo, NY 14202	Underground mine and plant.	Martin.
United States Gypsum Co.[3]	101 South Wacker Dr. Chicago, IL 60606	do	Do.
Lime:			
Inland Steel Co	3210 Watling St. East Chicago, IN 46312	Plant	Lake.
Marblehead Lime Co	300 West Washington St. Chicago, IL 60606	do	Do.

See footnotes at end of table.

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[1] State Liaison Officer, Bureau of Mines, Bloomington, Ind.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Peat:			
Ballards Peat Moss	Route 2 Warren, IN 46792	Bog and plant	Wells.
Glacier Peat Moss Corp	8360 South 450 East Jonesboro, IN 46938	do	Grant.
Herb Felger Peat Moss and Black Dirt.	9912 Valentine Rd. Fort Wayne, IN 46808	do	Allen.
Kenton Buesching Peat Moss & Black Dirt.	9134 Cook Rd., Route 3 Fort Wayne, IN 46825	do	Do.
Millburn Peat Co., Inc	Box 236 La Porte, IN 46350	do	La Porte.
Organic Products Co	2695 Cicero Rd. Noblesville, IN 46060	do	Hamilton.
Perlite, expanded:			
Airlite Processing Corp	R.R. 2 Scottsburg, IN 47170	Plant	Scott.
Chemrock Corp	End of Osage St. Nashville, TN 37208	do	Tippecanoe.
Grefco, Inc	2111 Enco Dr. Oakbrook, IL 60521	do	Montgomery.
Sand and gravel:			
American Aggregates Corp.[1]	Drawer 150 Greenville, OH 45331	Pits and plants	Hamilton, Marion, Wayne.
Martin Marietta Corp.[1]	Box 789 Cedar Rapids, IA 52406	do	Various.
Western Materials Co.[1]	Box 150, 600 Morland Dr. Lafayette, IN 47901	do	Do.
Smelters and refineries (nonferrous):			
Aluminum Company of America	Newburgh, IN 47530	Smelter	Warrick.
ASARCO Incorporated	2230 Indianapolis Blvd. Whiting, IN 46394	Plant	Lake.
NL Industries, Inc	3700 South Arlington Ave. Beech Grove, IN 46107	do	Marion.
USS Lead Refinery Inc	5300 Kennedy Ave. East Chicago, IN 46312	do	Lake.
Stone:			
France Stone Co.[4]	Box 1928 Toledo, OH 43603	Quarries and plants	Allen, Cass, Putnam.
Irving Bros. Gravel Co., Inc.[4]	3888 Garthwaite Rd. Marion, IN 46952	do	Delaware, Grant, Huntington, Wells.
Mulzer Crushed Stone Co	Box 248 Tell City, IN 47586	Quarries, mine, and plants.	Crawford, Perry.
Ralph Rogers & Co., Inc.[2] [4]	Box 849 Bloomington, IN 47401	Quarries and plants	Lawrence, Monroe, Newton.
Sulfur, recovered:			
American Oil Co	200 East Randolph Dr. Chicago, IL 60601	Refinery	Lake.
Energy Cooperative, Inc	3500 Indianapolis Blvd. East Chicago, IN 46312	do	Do.

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[1] Also stone.
[2] Also clays.
[3] Also expanded perlite.
[4] Also sand and gravel.

The Mineral Industry of Iowa

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Iowa for collecting information on all minerals.

By Waldemar M. Dressel[1] and Raymond R. Anderson[2]

The value of Iowa mineral production exceeded one-quarter of a billion dollars, an increase of 10% over 1976. This is the 10th consecutive year that the value of mineral production has reached a new high.

Cement is the leading mineral commodity in terms of value and accounts for 44% of the total. Other commodities, in order of importance, are stone, sand and gravel, gypsum, and coal. Lime and peat are also produced in the State and some perlite from outside the State is expanded at Iowa plants.

Cement production increased 9%; gypsum, 7%; and sand and gravel, 9%. Clay and stone production declined 13% and 4% respectively.

Nonmetallic minerals accounted for 97% of the total mineral output of the State. Portland and masonry cement accounted for 44% of the mineral production value. The remainder of the value was distributed as follows: Stone, 32%; sand and gravel, 14%; gypsum, 4%; and clays, 1%. Lime, peat, and gem stones accounted for the remainder.

Table 1.—Mineral production in Iowa[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	76	$4,143	86	$5,052
Portland do	2,438	86,107	2,645	99,383
Clays do	1,017	2,245	883	2,461
Coal (bituminous) do	616	8,351	513	6,518
Gem stones	NA	1	NA	1
Gypsum thousand short tons	1,486	8,288	1,593	10,035
Sand and gravel[2] do	15,206	26,277	16,600	33,290
Stone[3] do	30,272	75,921	29,183	76,964
Combined value of lime, peat, sand and gravel (industrial), and stone (dimension)	XX	4,694	XX	4,504
Total	XX	216,027	XX	238,208
Total 1967 constant dollars	XX	110,887	XX	[p]117,579

[p] Preliminary. NA Not available. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes industrial sand and gravel; value included with "Combined value" figure.

[3] Excludes dimension stone; value included with "Combined value" figure.

Table 2.—Value of mineral production in Iowa, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adair	W	W	Stone.
Adams	W	W	Do.
Allamakee	W	$480	Stone, sand and gravel.
Appanoose	$2,047	W	Stone, clays, sand and gravel.
Audubon	--	W	Sand and gravel.
Benton	1,188	W	Stone, sand and gravel.
Black Hawk	W	W	Do.
Boone	569	872	Sand and gravel.
Bremer	W	W	Stone, sand and gravel.
Buchanan	W	W	Do.
Buena Vista	W	281	Sand and gravel.
Butler	309	W	Stone, sand and gravel.
Calhoun	--	71	Sand and gravel.
Carroll	504	400	Do.
Cass	W	W	Stone.
Cedar	W	W	Stone, sand and gravel.
Cerro Gordo	W	W	Cement, stone, clays, sand and gravel.
Cherokee	652	721	Sand and gravel.
Chickasaw	342	W	Stone, sand and gravel.
Clarke	W	429	Stone.
Clay	160	W	Sand and gravel.
Clayton	1,834	2,763	Sand and gravel, stone.
Clinton	2,204	2,142	Stone, sand and gravel.
Crawford	W	W	Sand and gravel.
Dallas	W	671	Sand and gravel, clays.
Davis	W	W	Stone, sand and gravel.
Decatur	W	656	Stone.
Delaware	W	W	Stone, sand and gravel.
Des Moines	W	W	Gypsum, stone, sand and gravel.
Dickinson	338	359	Sand and gravel.
Dubuque	W	W	Stone, sand and gravel.
Emmet	229	320	Sand and gravel.
Fayette	1,376	1,246	Stone, sand and gravel.
Floyd	W	W	Stone, sand and gravel, clays.
Franklin	W	W	Do.
Fremont	W	W	Stone, sand and gravel.
Greene	W	463	Sand and gravel.
Grundy	50	27	Do.
Guthrie	W	26	Do.
Hamilton	W	W	Stone, sand and gravel.
Hancock	W	W	Sand and gravel, stone.
Hardin	3,353	4,336	Stone, sand and gravel.
Harrison	W	W	Do.
Henry	W	W	Do.
Howard	416	374	Do.
Humboldt	W	W	Do.
Ida	44	69	Sand and gravel.
Iowa	W	--	
Jackson	W	W	Stone, sand and gravel.
Jasper	W	W	Sand and gravel, stone.
Jefferson	W	W	Stone.
Johnson	W	W	Stone, sand and gravel.
Jones	1,374	1,832	Do.
Keokuk	W	W	Stone.
Kossuth	84	114	Sand and gravel.
Lee	W	W	Stone, sand and gravel.
Linn	3,820	4,778	Stone, sand and gravel, peat.
Louisa	W	W	Stone.
Lucas	W	24	Do.
Lyon	13	43	Sand and gravel.
Madison	W	W	Stone, clays.
Mahaska	W	W	Sand and gravel, stone.
Marion	W	W	Stone, sand and gravel, gypsum.
Marshall	W	W	Stone, sand and gravel.
Mills	W	W	Stone.
Mitchell	W	W	Stone, sand and gravel.
Monona	445	W	Sand and gravel.
Monroe	W	W	Stone, sand and gravel.
Montgomery	W	W	Stone.
Muscatine	W	W	Stone, sand and gravel.
O'Brien	W	139	Sand and gravel.
Osceola	W	368	Do.
Page	W	W	Stone, sand and gravel.
Palo Alto	348	324	Sand and gravel.
Plymouth	961	2,139	Do.
Pocahontas	W	W	Stone, sand and gravel.
Polk	W	W	Cement, sand and gravel, clays.
Pottawattamie	W	W	Stone, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Iowa, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Poweshiek	W	W	Stone.
Sac	$645	$907	Sand and gravel.
Scott	25,187	30,948	Cement, stone, lime, clays, sand and gravel.
Shelby	W	W	Sand and gravel.
Sioux	1,257	1,362	Do.
Story	W	W	Sand and gravel, stone, clays.
Tama	W	W	Stone, sand and gravel.
Taylor	W	6	Stone.
Union	W	W	Do.
Van Buren	W	W	Stone, sand and gravel.
Wapello	W	W	Sand and gravel, clays.
Warren	W	W	Sand and gravel.
Washington	W	W	Stone.
Webster	W	W	Gypsum, stone, sand and gravel, clays.
Winnebago	W	W	Sand and gravel, peat.
Winneshiek	W	1,289	Stone, sand and gravel.
Woodbury	233	W	Sand and gravel, clays.
Worth	W	W	Stone, sand and gravel, peat.
Wright	405	602	Sand and gravel.
Undistributed[2]	165,637	176,632	
Total[3]	216,027	238,208	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Ringgold and Wayne Counties are not listed because no production was reported.

[2] Includes some gem stones, sand and gravel, and coal that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

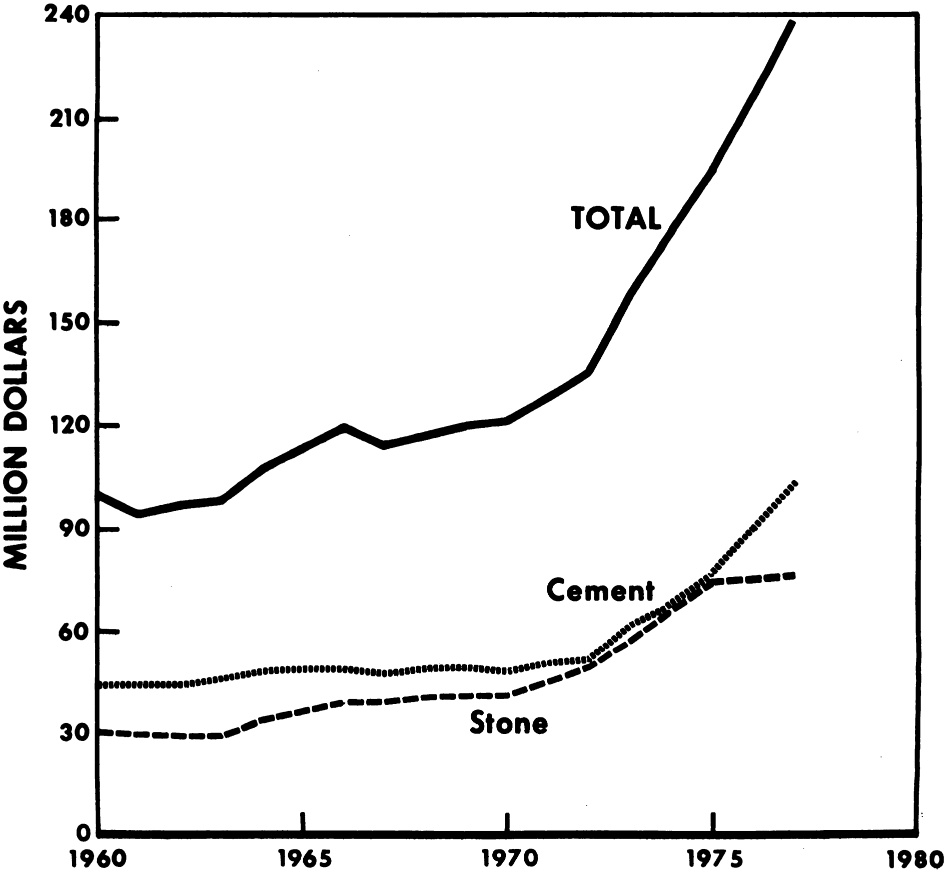

Figure 1.—Value of cement, stone, and total value of mineral production in Iowa.

Energy.—The Iowa Coal Research Project continued throughout 1977. This project included a demonstration mine to show that Iowa coal could be mined and the land could be reclaimed in an economically sound and environmentally acceptable manner. The project also included the construction and operation of a 70-ton-per-hour coal washing facility at Ames designed to demonstrate the improvements that could be achieved by washing Iowa coal.

Several other interesting research papers relating to coal mining in Iowa were published.[3] [4] One of these related to revegetation of stripped areas, and another related to the vertebrate inhabitants (excluding fish) of the area of southeast Iowa containing strippable coal reserves.

Environment.—A waste recovery system to separate garbage and recover energy from the refuse continued operation at a deficit in 1977. The plant was being improved.[5]

Recycling of asphalt was being accomplished in Kossuth County where a 300-ton-per-day plant breaks down old asphalt, heats it without burning, and mixes virgin asphalt with old asphalt. The plant is equipped with wet scrubbers for pollution control.

The staffs of four commissions making up the Iowa Department of Environmental Quality were merged for greater efficiencies.[6] The Air Quality and Solid Waste Disposal groups were merged into a new unit — Air and Land Quality Div. Chemical Technology and Water Pollution were merged into the Chemical and Water Quality Div.

A compilation of maps of underground and surface coal mines in eight Iowa counties was published.[7] This should be useful for many potential users such as construction engineers, geologists, environmentalists, planning agencies, etc.

Iowa Limestone Producers Association continued its Quarry Beautification Program. B. L. Anderson won this sweepstake award. Other award winners included Alpha Crushed Stone for the screening, stockpile, and yard and shop improvements; Dubuque Stone Products for office and scalehouse beautification; B. L. Anderson for entrance improvement and Kaser Corp. for overburden and reclamation improvements.

Exploration, Geologic Studies, Mapping.—Coal reserves were described briefly in an article published in Coal Age.[8] Iowa coal reserves are estimated at from 10 to 20 billion tons. Ten beds with reserves exceeding 6 billion tons were described.

The Department of Interior's Geological Survey, in conjunction with the Iowa Geological Survey, has a topographic mapping program underway and is attempting to cover the entire State with modern 7-1/2-minute quadrangle mapping. These maps will be especially useful in the mine land reclamation studies.

An intensive coal exploration program was conducted by the Iowa Geological Survey to obtain data that would encourage industry to look to Iowa as a potential area for coal production expansion. The coal reserve base has been expanded.

The Highway Div. of the Iowa Department of Transportation funded a graduate study of the economic potential of the Spergen Formation, Lower Mississippian, in southeastern Iowa. The study was being done by B. L. Milne, University of Iowa, with technical assistance from the Iowa Geological Survey. This study was scheduled for completion in 1978.

Safety.—Nonmetal mines operated with no fatal accidents during 1977. One fatal accident occurred in an underground coal mine.

Portland Cement Association safety awards were presented to Martin Marietta Aggregates, at Buffalo, A. J. Poirier, plant manager, for 15 years with no disabling injuries, and Northwestern States Portland Cement, Mason City, D. N. Erdenberger, operations manager, for 8 years with no disabling injuries.

National Crushed Stone Association safety awards were earned by Martin Marietta Aggregates and Kaser Corp. for the following operations: Martin Marietta Aggregates' Cedar Rapids, Earlham, and Marshalltown quarries; Kaser Corp.'s Eddyville, Glenwood, Greensburg, Harper, Meadiapolis, New Sharon, and Stennet quarries; New Harvey and Tracy sand pits; Durham pelletizing plant; and Oskaloosa mine and mill.

Climax Molybdenum commissioned a new $40 million roasting facility at Fort Madison.

The Iowa Department of Transportation program to certify testing technicians for aggregate testing was described in the May 1977 issue of Rural and Urban Roads.[9] This program enabled the producers of limestone to better control the product and reduce the cost of highway department inspections.

Employment.—Approximately 2,300 persons were employed in the coal and noncoal mining industry in 1977. This figure does not include the 7,600 persons employed in the manufacture of nonmetallic mineral products such as cement, lime, gypsum products, brick and tile, ready-mix concrete, and concrete products. Also not included are 8,000 persons employed in the primary metal industry at smelters, ferrous and nonferrous foundries, and rolling, drawing, and extruding operations.

Table 3.—Indicators of Iowa business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ..... thousands	1,337.0	1,385.0	+3.6
Unemployment ..... do	53.0	56.0	+5.7
Employment (nonagricultural):			
Mining ..... do	2.5	2.3	-8.0
Manufacturing ..... do	234.0	242.3	+3.5
Contract construction ..... do	53.0	53.9	+1.7
Transportation and public utilities ..... do	53.8	54.5	+1.3
Wholesale and retail trade ..... do	265.2	271.2	+2.3
Finance, insurance, real estate ..... do	49.9	51.7	+3.6
Services ..... do	181.7	187.2	+3.0
Government ..... do	197.0	203.2	+3.1
Total nonagricultural employment ..... do	1,037.1	1,066.3	+2.8
Personal income:			
Total ..... millions	$17,738	$19,802	+11.6
Per capita	$6,172	$6,878	+11.4
Construction activity:			
Number of private and public residential units authorized	19,448	20,591	+5.9
Value of nonresidential construction ..... millions	$268.1	$261.9	-2.3
Value of State road contract awards ..... do	$159.5	$177.0	+11.0
Shipments of portland and masonry cement to and within the State ..... thousand short tons	1,832	1,791	-2.2
Mineral production value:			
Total crude mineral value ..... millions	$216.0	$238.2	+10.3
Value per capita, resident population	$75	$83	+10.7
Value per square mile	$3,838	$4,232	+10.3

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Portland cement shipments increased 8% in quantity and 15% in value over that of 1976. Ready-mix companies accounted for the largest percentage increase (15%) over that of 1976. Highway construction use accounted for 2% more than in 1976.

Most of Iowa cement production is used in Iowa. Disposition of portland cement shipped by Iowa manufacturers was as follows: Ready-mix concrete, 67%; concrete products, 20%; highway construction, 7%; building material dealers, 5%; and other customers, 1%.

Five companies operated a total of 18 kilns at 3 wet-process and 2 dry-process plants. Production amounted to 80% of the rated capacity.

Masonry cement was produced by Northwestern States Portland Cement Co., Marquette Cement Manufacturing Co., and Martin Marietta Corp. A 13% increase in quantity and a 22% increase in value was achieved over that of 1976. The average value of masonry cement increased to $58.74 per ton.

Martin Marietta announced preliminary plans for a new and larger dry-process cement plant to replace the existing 510,000-ton-per-year wet-process facility in Buffalo. Two engineering firms were selected to perform parallel studies that will determine the size and cost of the proposed plant.

Lehigh Portland Cement Co. announced a modernization and expansion program at the Mason City plant. The construction of a 13- by 184-foot kiln with preheater would allow for the retirement of six old kilns with a capacity of 365,000 tons per year. Total plant production would be increased approximately 20% to 750,000 tons per year.

Northwestern States Portland Cement Co. with 300 employees completed construction of a 500-foot kiln in 1976. This kiln has a production capacity of 850 tons per hour. Northwestern's total production capacity is more than 1 million tons per year.

Clay and Shale.—Clay and shale were produced by all 11 companies operating 15 mines in 12 counties. The three largest companies produced 62% of the total clay output; 4 companies accounted for 32% of the total; and the 5 smallest companies accounted for the remaining 6%. Thirty-eight percent of the clay was produced in Cerro Gordo County.

Cement companies utilized 43% of the clay production, 8% was used in the manufacture of drain tile and the remainder for brick, flue lining, roof tile, and expanded aggregate for concrete production.

Clay drain tile production was down approximately 52% from that of 1976 reflecting strong competition from the plastic pipe industry.

Gypsum.—United States Gypsum Co., National Gypsum Co., Georgia Pacific Corp., Jim Walter Corp., and Kaser Construction Co. produced 1.6 million tons of gypsum from mines in Des Moines and Webster Counties. Gypsum production was up 7% over that of 1976 as record production was achieved for the second year.

United States Gypsum operated an underground mine near Sperry in Des Moines County and a surface mine at Fort Dodge in Webster County. Jim Walter Corp. (Celotex Corp.), Georgia-Pacific, and National Gypsum also operate open pit mines in Fort Dodge. Each of the above named companies operated calcining facilities and wallboard plants near the mine site. Kaser Construction Co. produced gypsum at Harvey in Marion County from a dual product gypsum-limestone mine. Much of the production from Kaser is mixed with ground limestone and pelletized for use as soil conditioner.

Lime.—Quicklime and hydrated lime output remained virtually unchanged although there was a 5% increase in value. Linwood Stone Products Co., in Scott County, remained the State's sole producer of quicklime and hydrated lime.

Peat.—Three companies reported either moss or reed sedge peat production in Linn, Winnebago, and Worth Counties. Most of the peat was sold in bulk for general soil improvement. The average value of the peat produced was $7.70 per cubic yard.

Perlite.—National Gypsum Co. and United States Gypsum Co. continued to operate perlite expansion facilities at their Fort Dodge gypsum calcining plants in Webster County. The perlite is mined elsewhere and shipped to Iowa for processing. All of the expanded perlite was used for plaster aggregate.

Sand and Gravel.—Sand and gravel production increased 9% to 16.6 million tons. This was made up as 53% sand and 47% gravel. Concrete aggregate continued to be the principal use for the sand and gravel, followed by roadbase and coverings, asphaltic concrete fill, concrete products, and other. The average value for sand was $1.93 per ton and for gravel, $2.09 per ton.

There were 232 sand and gravel operations in Iowa. The size of individual operations ranged from less than 25,000 tons to more than 500,000 tons per year. Over 50% of the operations produced less than 50,000 tons each, 17% produced 50,000 to 100,000 tons, 16% produced between 100,000 and 200,000 tons, and 7% produced over 200,000 tons.

Table 4.—Iowa: Construction sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

	1976		1977	
	Quantity	Value	Quantity	Value
Sand	8,200	13,664	8,871	17,144
Gravel	7,006	12,612	7,728	16,146
Total[1]	15,206	26,277	16,600	33,290

[1] Data may not add to totals shown because of independent rounding.

Table 5.—Iowa: Sand and gravel sold or used by producers, by county[1]

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Allamakee	--	--	--	2	16	28
Appanoose	--	--	--	1	100	150
Benton	3	140	232	2	W	W
Black Hawk	6	141	277	7	455	870
Boone	7	374	569	8	456	872
Bremer	2	W	W	3	29	55
Buena Vista	2	W	W	3	164	281
Butler	1	20	14	1	W	W
Calhoun	--	--	--	1	47	71
Carroll	6	271	504	5	222	400
Cerro Gordo	3	149	257	3	218	611
Cherokee	6	361	652	7	323	721
Chickasaw	1	21	42	1	16	32
Clay	5	185	160	2	W	W
Clayton	3	222	960	4	516	902
Clinton	5	844	625	4	155	324
Dallas	5	359	401	5	243	436
Davis	1	70	190	1	100	299
Dickinson	5	239	338	5	214	359
Emmet	3	163	229	3	182	320
Fayette	5	57	72	4	49	91
Franklin	4	244	347	6	206	382
Greene	6	W	W	6	268	463
Grundy	1	18	50	1	9	27
Guthrie	--	--	--	1	10	26
Hamilton	3	318	646	3	42	71
Hancock	7	W	W	7	255	547
Hardin	7	275	272	7	389	656
Howard	1	16	30	1	6	8
Ida	1	56	44	1	46	69
Jones	5	77	132	7	155	258
Kossuth	3	108	84	3	101	114
Linn	4	482	966	4	527	1,030
Lyon	3	11	13	3	19	43
Marion	4	272	482	4	294	569
Marshall	3	293	496	5	322	627
Monroe	--	--	--	1	33	132
Muscatine	4	598	1,199	4	567	1,050
O'Brien	2	W	W	3	91	139
Osceola	--	--	--	3	202	368
Palo Alto	1	181	348	1	180	324
Plymoth	4	578	961	4	1,312	2,139
Pocahontas	1	113	89	1	19	29
Polk	5	1,276	2,641	7	1,821	4,335
Sac	3	350	645	5	445	907
Scott	--	--	--	3	352	863
Sioux	6	693	1,257	6	735	1,362
Van Buren	--	--	--	1	92	W
Wapello	--	--	--	1	213	509
Warren	--	--	--	1	35	W
Webster	3	117	151	6	298	601
Winneshiek	--	--	--	1	53	137
Woodbury	3	142	155	2	W	W
Worth	2	W	W	3	252	445
Wright	4	279	405	7	317	602
Undistributed[2]	53	5,092	9,342	41	3,426	7,636
Total[3]	212	15,206	26,277	232	16,600	33,290

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Excludes industrial sand and gravel.

[2] Includes Allamakee, Appanoose (1976), Audubon (1977), Bremer (1976), Buchanan, Buena Vista (1976), Butler (1977), Cedar, Crawford, Delaware, Des Moines, Dubuque (1977), Floyd, Fremont, Greene (1976), Guthrie (1976), Hancock (1976), Harrison, Henry, Humboldt, Jackson, Jasper, Johnson, Lee, Mahaska, Mitchell, Monona, O'Brien (1976), Osceola (1976), Page, Pottawattamie (1977), Scott (1976), Shelby, Story, Tama, Van Buren (1976), Wapello (1976), Warren (1976), Winnebago, Winneshiek (1976), and Worth (1976) Counties, and counties indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 6.—Iowa: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	5,445	11,646	7,271	17,028
Concrete products	1,379	2,871	554	1,321
Asphaltic concrete	2,867	5,301	3,189	5,639
Roadbase and coverings	3,539	3,895	3,202	6,039
Fill	1,680	2,134	2,254	3,050
Railroad ballast	--	--	16	46
Other	298	429	115	166
Total[1]	15,206	26,277	16,600	33,290

[1]Data may not add to totals shown because of independent rounding.

Stone.—W. C. Weber Stone Co. and W. Becker & Sons Stone Co. quarried dimension limestone at three quarries for rubble, cut building stone, rough construction stone, house stone veneer, and sawed building stone. Crushed limestone was produced by 70 companies at 320 quarries for roadbase stone, other aggregate roadstone, surface treatment aggregate, and other uses. Output decreased 4% to 29.2 million tons valued at $77 million. Leading producers were Martin Marietta Corp., Kaser Construction Co., and B. L. Anderson, Inc.

Table 7.—Iowa: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	4,942	11,540	6,028	15,190
Roadstone	4,717	10,220	4,813	11,870
Surface treatment aggregate	5,706	14,770	4,366	11,270
Concrete aggregate	3,380	10,580	3,971	12,980
Cement manufacture	3,721	7,436	3,787	7,044
Agricultural limestone	4,155	10,950	2,816	9,226
Bituminous aggregate	1,469	3,791	1,542	4,424
Railroad ballast	1,017	2,221	893	2,162
Riprap and jetty stone	176	554	190	562
Macadam aggregate	81	144	58	115
Mineral food	W	W	12	78
Filter stone	W	W	7	25
Other uses[1]	907	3,714	701	2,007
Total[2]	30,272	75,921	29,183	76,964

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1]Includes stone used in lime manufacture, other filler (1977), flux stone, soil conditioners, asphalt filler, fill, other use, and uses indicated by symbol W.

[2]Data may not add to totals shown because of independent rounding.

MINERAL FUELS

Coal (Bituminous).—Coal production struggled at a reduced rate as the market for Iowa high sulfur coal remained depressed.

Petroleum and Natural Gas.—One unsuccessful wildcat oil test was drilled in southwestern Iowa.

Natural Gas Pipe Line Co. obtained permits to drill 25 injection-withdrawal wells for their storage facility in Louisa County.

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[1]State Liaison Officer, Bureau of Mines, Rolla, Mo.

[2]Senior research geologist, Iowa Geological Survey, Iowa City, Iowa.

[3]Carvey, K., D. R. Farrar, and D. G. Glenn-Lewin. Bryophytes and Revegetation of Coal Spoils in Southern Iowa. IS-ICP-34.

[4]Glenn-Lewin, D. G., and J. Voight. Vertebrates (Excluding Fish) in the Coal Strip Mining Region of Southeast Iowa. October 1976, IS-ICP-34, NTIS 8 26100760.

[5]Des Moines Register. Jan. 12, 1978.

[6]Des Moines Register. July 28, 1977.

[7]Harl, N. E., J. B. Achterhof, P. F. Anderson, and K. Wiese. Coal Mine Maps for Eight Iowa Counties. Agri. and Home Econ. Exp. Stat., Iowa State Univ. Sci. and Technol. Misc. Bull. 12, October 1977.

[8]Mid America Report. Coal Renaissance Comes to Southern Iowa Farm Lands. Coal Age, May 1977.

[9]Calvert, G. Certification of Technicians in Iowa's Aggregate Testing. Rural and Urban Roads, May 1977, pp. 31-32.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Lehigh Portland Cement Co.[1]	Young Building 718 Hamilton St. Allentown, PA 18105	Plant	Cerro Gordo.
Marquette Cement Manufacturing Co.[1,2]	First American Center Nashville, TN 37238	do	Polk.
Martin Marietta Corp.[1,2,3]	11300 Rockville Pike Rockville, MD 20852	do	Scott.
Northwestern States Portland Cement Co.[1,2]	12 Second St. NE. Mason City, IA 50401	do	Cerro Gordo.
Penn-Dixie Cement Corp.[2]	60 East 2d St. New York, NY 10017	do	Polk.
Clay and shale:			
Can-Tex Industries, Div. of Harsco	101 Ashworth Rd. Des Moines, IA 50265	Pits and plants	Cerro Gordo, Dallas, Keokuk, Mahaska.
Carter-Waters Corp	2440 Pennway Kansas City, MO 64100	do	Appanoose.
Sioux City Brick & Tile	222 Commerce Bldg. Sioux City, IA 51102	do	Dallas and Woodbury.
W. S. Dickey Clay Manufacturing Co	Box 6 Pittsburg, KS 66762	do	Webster.
Coal (bituminous):			
Lovilia Coal Co	Route 2 Melrose, IA 52569	Underground mine	Monroe.
Star Coal Co	802 Lincoln St. Pella, IA 50219	Strip mines	Mahaska.
Ferroalloys:			
Foote Mineral Co	320 Concert St. Keokuk, IA 52632	Plant	Lee.
Gypsum:			
The Celotex Corp	1500 North Dale Mabry Tampa, FL 33607	Pit and plant	Webster.
Georgia-Pacific Corp	900 SW 5th Ave. Portland, OR 97204	do	Do.
National Gypsum Co.[4]	325 Delaware Ave. Buffalo, NY 14202	do	Do.
United States Gypsum Co.[4]	101 South Wacker Dr. Chicago, IL 60606	Mines and plant	Des Moines and Webster.
Lime:			
Linwood Stone Products Co.[2]	Route 2 Davenport, IA 52804	Plant	Scott.
Peat:			
Eli Colby Co	Box 248 Lake Mills, IA 50450	Pit and plant	Winnebago.
Colby Pioneer Peat Co	Box 8 Hanlontown, IA 50444	do	Worth.
Sand and gravel:			
Acme Aggregates	Route 1, Box 210 Comanche, IA 52730	do	Clinton.
Acme Fuel & Materials	Box 34 Muscatine, IA 52761	do	Muscatine.
L. G. Everist, Inc	302 Paulton Bldg. Sioux Falls, SD 57102	do	Plymoth and Sioux.
G. A. Finley, Inc	Box 465 Harlan, IA 51537	do	Crawford, Montgomery, Page, Shelby.
Hallett Construction Co.[2]	Box 13 Boone, IA 50036	do	Boone, Carroll, Cerro Gordo, Cherokee, Franklin, Fremont, Hamilton, Iowa, Marshall, Sac, Story.
Maudlin Construction Co	Box 134 Webster City, IA 50595	do	Boone, Buena Vista, Cerro Gordo, Cherokee, Clay, Franklin, Hamilton, Hardin, Kossuth, Lyon, Marshall, Osceola, Plymoth, Polk, Sac, Story, Warren, Woodbury, Worth, Wright.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
West Des Moines Sand Co	Box 98 West Des Moines, IA 50265	Pit, and plant	Polk.
Stone:			
Alpha Crushed Stone, Inc	Box 267 Marion, IA 52302	Quarries and plants	Cedar, Clinton, Jones, Linn.
B. L. Anderson, Inc	327 Guaranty Bldg. Cedar Rapids, IA 52400	do	Benton, Buchanan, Cedar, Jackson, Jones, Linn, Tama.
Kaser Construction Co.[5]	7200 Hickman Rd. Des Moines, IA 50322	do	Des Moines, Fremont, Jasper, Keokuk, Mahaska, Marion, Mills, Monroe, Montgomery, Poweshiek, Washington.
Rapid Quarries Corp., Div. of Medusa Corp.[3]	Box 1085 Burlington, IA 52601	do	Des Moines, Jefferson, Lee, Van Buren.
Schildberg Construction Co., Inc	Box 358 Greenfield, IA 50849	do	Adair, Adams, Cass, Madison, Pottawattamie, Union.
Weaver Construction Co	Box 817 Iowa Falls, IA 50126	do	Cerro Gordo, Franklin, Hamilton, Hardin.
Welp & McCarten, Inc.[3]	522 South 22d St., Box W Fort Dodge, IA 50501	do	Black Hawk, Cerro Gordo, Hancock, Howard, Humboldt, Webster, Worth.
Wendling Quarries, Inc	Atalissa, IA 52720	do	Cedar, Delaware, Dubuque, Mascatine.

[1] Also clays.
[2] Also stone.
[3] Also sand and gravel.
[4] Also expanded perlite.
[5] Also gypsum.

The Mineral Industry of Kansas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey of Kansas for collecting information on all minerals except fuels.

By Robert B. McDougal[1] and Carol Zarley[2]

Kansas mineral output in 1977 was valued at $1.4 billion, an increase of $156 million above the 1976 figure. In terms of mineral production value, Kansas ranked 16th among all the States. Of the 14 mineral commodities produced, all but 1 registered value increases.

Table 1.—Mineral production in Kansas[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Cement:				
Masonry ______ thousand short tons__	72	$3,281	79	$3,742
Portland __________________do____	2,005	66,478	2,020	72,815
Clays[2] __________________do____	1,064	1,869	1,117	1,965
Coal (bituminous) _____________do____	590	11,473	897	16,983
Helium (high-purity) __ million cubic feet__	503	11,066	W	W
Lime __________ thousand short tons__	W	W	15	409
Natural gas ________ million cubic feet__	829,170	348,251	781,289	378,925
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels________	6,434	31,017	31,022	190,811
LP gases __________________do____	23,767	83,422		
Petroleum (crude) _____________do____	58,714	557,783	57,496	574,960
Salt[3] __________ thousand short tons__	1,310	35,291	1,430	41,154
Sand and gravel[4] ______________do____	12,291	14,940	13,973	23,299
Stone (crushed)[5] ______________do____	16,348	38,228	17,229	41,807
Combined value of clays (bentonite), diatomite (1976), gypsum, helium (crude), salt (brine), sand and gravel (industrial), stone (dimension) and values indicated by symbol W ___	XX	[r]10,749	XX	22,627
Total_______________________	XX	[r]1,213,848	XX	1,369,497
Total 1967 constant dollars ________	XX	436,378	XX	[p]675,984

[p]Preliminary. [r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes bentonite; value included in "Combined value" figure.

[3]Excludes salt in brines; value included in "Combined value" figure.

[4]Excludes industrial sand and gravel; value included in "Combined value" figure.

[5]Excludes dimension stone; value included in "Combined value" figure.

Table 2.—Value of mineral production in Kansas, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Allen	$16,975	W	Cement, stone, clays.
Anderson	W	$340	Stone.
Atchison	W	W	Do.
Barber	14,824	W	Gypsum, sand and gravel.
Barton	28,378	1,280	Sand and gravel, clays.
Bourbon	W	534	Stone.
Butler	W	904	Do.
Chase	311	W	Do.
Chautaugua	W	22	Do.
Cherokee	W	W	Sand and gravel, stone, clays.
Cheyenne	W	103	Sand and gravel.
Clark	1,876	40	Do.
Clay	W	W	Sand and gravel, stone.
Cloud	W	W	Sand and gravel, clays, stone.
Coffey	1,146	2,517	Stone.
Comanche	2,447	13	Sand and gravel.
Cowley	21,444	3,807	Stone, sand and gravel.
Crawford	W	W	Stone, clays.
Decatur	W	104	Sand and gravel.
Dickinson	951	950	Stone, sand and gravel.
Doniphan	W	W	Do.
Douglas	W	W	Do.
Edwards	3,597	167	Sand and gravel.
Elk	W	2,047	Stone.
Ellis	W	292	Sand and gravel, stone.
Ellsworth	52,994	W	Helium(high-purity), salt, sand and gravel, clays.
Finney	11,942	W	Sand and gravel, stone.
Ford	1,575	610	Sand and gravel.
Franklin	W	W	Stone, clays.
Geary	W	W	Sand and gravel, stone.
Gove	W	57	Sand and gravel.
Graham	W	47	Do.
Grant	W	W	Helium (high-purity), sand and gravel.
Gray	W	197	Sand and gravel.
Greeley	3	--	
Greenwood	W	677	Stone.
Hamilton	3,528	111	Sand and gravel.
Harper	4,648	167	Do.
Harvey	W	W	Do.
Haskell	12,181	140	Do.
Hodgeman	9,905	66	Do.
Jackson	W	147	Stone, sand and gravel.
Jefferson	1,137	1,605	Stone.
Jewell	1,659	W	Stone, sand and gravel.
Johnson	W	W	Do.
Kearny	3,427	332	Sand and gravel.
Kingman	23,990	48	Do.
Kiowa	9,235	298	Do.
Labette	889	955	Stone.
Lane	3,436	--	
Leavenworth	W	999	Stone.
Lincoln	W	W	Stone, sand and gravel.
Linn	489	439	Stone.
Logan	W	--	
Lyon	W	W	Stone, sand and gravel.
McPherson	14,209	W	Stone, clays, sand and gravel.
Marion	W	--	
Marshall	W	W	Gypsum, sand and gravel, stone.
Meade	6,870	55	Sand and gravel.
Miami	532	464	Stone.
Mitchell	26	--	
Montgomery	W	W	Cement, stone, clays.
Morris	W	W	Stone.
Morton	37,571	W	Helium (high-purity), sand and gravel.
Nemaha	W	W	Stone.
Neosho	W	W	Cement, stone, sand and gravel, clays.
Ness	25,740	130	Sand and gravel.
Norton	W	28	Do.
Osage	231	521	Stone.
Osborne	W	--	
Ottawa	5	27	Sand and gravel.
Pawnee	6,078	164	Do.
Phillips	W	W	Stone, sand and gravel.
Pottawatomie	W	W	Do.
Pratt	W	W	Sand and gravel.
Rawlins	W	40	Do.
Reno	33,490	W	Salt, sand and gravel.
Republic	W	W	Sand and gravel.
Rice	37,710	W	Salt, stone, sand and gravel.
Riley	W	W	Stone, sand and gravel.
Rooks	W	24	Sand and gravel.
Rush	W	W	Helium (high-purity), helium (crude).
Russell	W	95	Sand and gravel.
Saline	W	587	Do.
Scott	9,827	15	Do.
Sedgwick	W	W	Sand and gravel, salt.

See footnotes at end of table.

Table 2.—Value of mineral production in Kansas, by county[1] [2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Seward	$26,209	W	Sand and gravel.
Shawnee	W	W	Stone, sand and gravel.
Sheridan	W	$102	Sand and gravel.
Sherman	W	510	Lime, sand and gravel.
Smith	W	W	Stone.
Stafford	W	75	Sand and gravel.
Stanton	194	--	
Stevens	3,160	W	Sand and gravel.
Sumner	W	W	Do.
Thomas	W	253	Do.
Trego	W	238	Do.
Wabaunsee	W	W	Stone.
Wallace	W	24	Sand and gravel.
Washington	W	W	Sand and gravel, stone.
Wichita	W	33	Sand and gravel.
Wilson	13,692	W	Cement, stone, clays.
Woodson	283	W	Stone.
Wyandotte	20,882	W	Cement, stone, sand and gravel.
Undistributed[3]	[r]744,147	1,346,091	
Total[4]	[r]1,213,848	1,369,497	

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Brown County is not listed because no production was reported.

[2] Values of petroleum and natural gas are based on average prices per barrel and cubic foot, respectively, for the State.

[3] Includes petroleum, natural gas, natural gas liquids, and coal that cannot be assigned to specific counties, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Kansas business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,080.0	1,119.0	+3.6
Unemployment	do.	46.0	45.0	-2.2
Employment (nonagricultural):				
Mining	do.	10.9	11.8	+8.3
Manufacturing	do.	166.6	171.2	+2.8
Contract construction	do.	45.2	44.7	-1.1
Transportation and public utilities	do.	56.7	58.2	+2.6
Wholesale and retail trade	do.	203.9	209.3	+2.6
Finance, insurance, real estate	do.	40.7	42.6	+4.7
Services	do.	141.9	150.0	+5.7
Government	do.	171.6	176.6	+2.9
Total nonagricultural employment	do.	837.5	864.4	+3.2
Personal income:				
Total	millions	$14,959	$16,594	+10.9
Per capita		$6,507	$7,134	+9.6
Construction activity:				
Number of private and public residential units authorized		15,717	17,524	+11.5
Value of nonresidential construction	millions	$192.0	$238.4	+24.2
Value of State road contract awards	do.	$125.2	$161.9	+29.3
Shipments of portland and masonry cement to and within the State	thousand short tons	1,263	1,263	--
Mineral production value:				
Total crude mineral value	millions	$1,213.8	$1,369.5	+12.8
Value per capita, resident population		$525	$589	+12.2
Value per square mile		$14,755	$16,648	+12.8

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

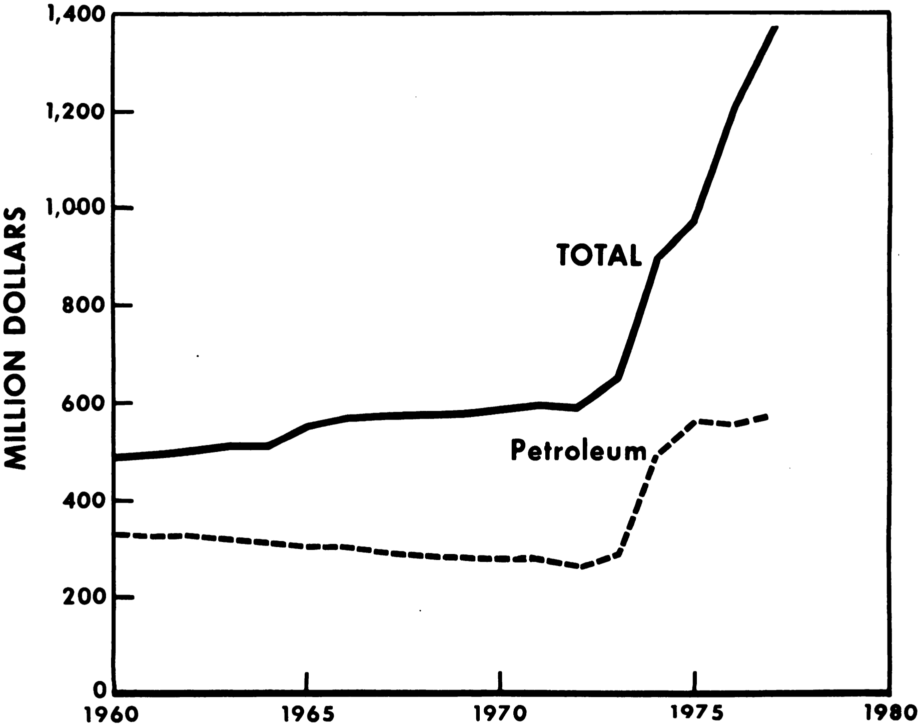

Figure 1.—Value of petroleum and total value of mineral production in Kansas.

Trends and Developments.—Historically, mineral fuels — petroleum, natural gas, natural gas liquids, and coal — have accounted for a significant portion of Kansas' mineral production value. In 1977, this share was 85% of the total, the same as in 1976.

Limestone, one of the chief building materials used by Kansas settlers, is holding its own against more modern alternative materials according to a report issued by the Kansas Geological Survey,[3] owing to its durability, low maintenance, availability, fuel conservation features, and appearance.

In its Phoenix Quarterly, the Institute of Scrap Iron and Steel reported that more than 121 million tons of ferrous scrap sits rusting in the seven States, including Kansas, that comprise the Census Bureau's West North Central Region. High collection costs and tax laws, that encourage exploration for and extraction of virgin raw materials currently make it more economical to mine and process iron ore than to recycle discarded iron and steel products.

Employment.—The nonfuels sector of the minerals industry employed 1,500 persons in 1977, up from 1,350 persons in 1976, as reported by the Employment Division, Kansas Department of Human Resources (DHR).

Highway improvement contracts totaling $175.3 million were awarded by the Kansas Department of Transportation in 1977. This represented a 24% increase from 1976 contracts of $140.9 million and included construction of interstate and primary State highways, county secondary roads, and bridges, as well as maintenance of these facilities. Interstate and primary State highway contracts were $144 million, or about 82% of the total. County project contracts totaled $13.8 million, and city contracts were $16.7 million. Highway maintenance resurfacing projects were let on 1,088 miles of highway during 1977. Contracts for safety projects totaled $800,000.

Table 4.—Kansas: Injuries, fatalities, and occupational disease in the nonfuel mineral industry

	Injuries			Fatalities	Occupational disease	
	Lost time	No lost time	Total		Lost time	No lost time
1976:						
Nonmetallic mining and quarrying	78	46	124	1	--	--
Other mining	38	23	61	--	--	--
Total	116	69	185	1	--	--
1977:						
Nonmetallic mining and quarrying	59	43	102	--	--	--
Other mining	21	32	53	--	--	--
Total	80	75	155	--	--	--

Source: Division of Workers' Compensation, Kansas Department of Human Resources.

Legislation and Government Programs.—Under Kansas Senate Bill 34, the owners or operators of underground stone or coal mines must furnish the Secretary of the Kansas Department of Human Resources an amended mine map each year in July. The amended map must record the progress of the workings from the previous year. Additional changes require owners or operators of all mines in Kansas, except stone quarries and sand and gravel operations, to file annual production information with the Kansas Geological Survey.

In House Bill 2559, the 1977 State Legislature amended and extended the act under which solid waste management and disposal is regulated to include specific provisions relating to the management and disposal of hazardous wastes. In general, the bill requires the Secretary of Health and Environment to adopt rules and regulations relating to all phases of handling, storage, and disposal including the obtaining of permits from the Secretary; places certain duties on the Secretary and persons engaged in the management or disposal of hazardous wastes; establishes a criminal penalty for violations of specific acts; authorizes the Secretary of Health and Environment to assess civil penalties; and makes certain changes in the statutory provisions relating to solid waste management and disposal.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal was produced at mines in Bourbon, Cherokee, Crawford, and Wilson Counties in southeastern Kansas. Five new surface mines were opened in 1977, three in Bourbon County and two in Crawford County. The output of coal came primarily from mines not affected by the lengthy coal miners' strike, which began December 1 and lasted well into 1978.

In 1977, natural gas was produced from 9,490 wells in 422 pools and fields, of which 5 fields accounted for almost 86% of the State's production. Hugoton in southwestern Kansas, largest of these fields, singly supplied 66% of the State output, followed by Panoma with 13%.

Crude petroleum production was reported to be 57.5 million barrels, a 2.1% decline from 1976, as production reached a 40-year low in Kansas. Value of crude petroleum produced in the Nation's eighth largest producing state was $575 million in 1977 and accounted for 42% of Kansas' total mineral production value. The five leading counties and their production in thousand barrels follow: Russell, 4,687; Ellis, 4,617; Barton, 2,793; Ness, 2,553; and Rooks, 2,455. Output from these counties provided 29.7% of the State's production. Bemis-Shutts and Hall-Gurney, the two largest fields, produced 5.6% of the State's petroleum output in 1977.

NONMETALS

Total value of nonmetallic minerals produced in 1977 was $207.8 million, compared with $181.9 million in 1976, a 14% increase. Portland cement was the major contributor to the total nonmetal value with 35%, stone 20%, salt 20%, and sand and gravel 11%.

Cement.—Portland cement output in 1977 was 2.07 million tons, up 6% from 1976 production of 1.95 million tons. The value of portland cement shipments was $72.8 million, a gain of nearly 10% from the 1976 value of $66.5 million. Distribution of cement to customers included ready-mixed concrete firms, 68%; highway contractors, 9%; concrete products manufacturers, 7%; building material dealers, 6%; and other uses, 10%. Lone Star Industries, Inc., completed remodeling of grinding facilities and installation of the final phase of pollution control equipment at its Bonner Springs plant.

Table 5.—Kansas: Portland cement salient statistics

	1976	1977
Number of active plants	5	5
Production short tons	1,950,352	2,072,478
Shipments from mills:		
Short tons	2,005,467	2,019,990
Value	$66,478,111	$72,814,839
Stocks at mills, Dec. 31 short tons	189,191	129,913

Table 6.—Kansas: Masonry cement salient statistics

	1976	1977
Number of active plants	5	5
Production short tons	70,291	69,635
Shipments from mills:		
Short tons	72,385	79,377
Value	$3,280,846	$3,741,745
Stocks at mills, Dec. 31 short tons	17,946	8,240

Clays.—The quantity of common clay and shale mined in Kansas totaled 1.1 million tons valued at $2 million in 1977. Clay and shale were mined by 12 firms with a total of 23 mines in 11 counties. The material was used for common and face brick, pottery, lightweight aggregate in concrete block and structural concrete, sewer and drain tile, and in the preparation of portland cement. Bentonite was mined in Neosho County by one firm. In May, Excelsior Clay Products, Inc., became Excelsior Brick Corp. Humboldt Shale Mining Co. changed its name to Humboldt Brick and Tile Co.

Gypsum.—Output at the National Gypsum Co. mine in Barber County and Georgia-Pacific Corp. mine in Marshall County for gypsum-board products, portland cement, and other uses increased nearly 10% in 1977. Calcined gypsum output was slightly greater. Value of both crude and calcined gypsum declined substantially from the 1976 levels.

Lime.—Great Western Sugar Co., Kansas' only lime producer, used lime in sugar refining at its Sherman County plant near Goodland. Output increased and value rose substantially in 1977.

Perlite.—Lite Weight Products, Inc., Wyandotte County, produced and sold expanded perlite. Production in 1977 increased nearly 5% in quantity and 10% in value. Major uses of perlite were horticultural aggregates 48%, masonry and cavity fill insulation 19%, and filter aid 14%. Minor uses comprised plaster aggregates 6%, concrete aggregates 4%, and other 9%.

Pumice (Volcanic Ash).—BASF Wyandotte Corp.'s Calvert mine in Norton County was inactive during 1976 and 1977. Mine and plant facilities were sold to Calvert Mines, Inc., Midwest City, Okla., in mid-1977.

Salt.—Production of salt (excluding brine) increased 9.2% in volume and 16.6% in value over 1976 output. Kansas' salt production was derived from the Wellington Formation by six firms using different techniques in Ellsworth, Reno, Rice and Sedgwick Counties. Two firms mined salt through solution techniques to produce evaporated salt, one firm mined salt underground, and two companies produced salt using both methods. The sixth firm produced salt brine from brine wells in Sedgwick County for use in the chemical industry.

Table 7.—Kansas: Evaporated and rock salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt	
	Quantity	Value	Quantity	Value
1973	782	19,914	615	3,547
1974	778	23,127	589	3,880
1975	771	26,274	675	4,940
1976	785	30,795	525	4,496
1977	822	34,790	608	6,364

Sand and Gravel.—Production from 168 pits and dredging operations increased nearly 14% and value rose almost 56% in 1977. Sand and gravel is the most widespread nonfuel mineral commodity produced, being mined in 71 counties. Almost two-thirds of the State's total sand and gravel production is derived from the Arkansas and Kansas Rivers and their associated alluvial deposits. Open pit operations, mainly in sands and gravels associated with the vast Ogallala Formation (Pliocene in age), are common in the western counties. Counties leading in the output of sand and gravel were Sedgwick, Wyandotte, Barton, Reno, and Shawnee.

Among the largest producers were Holliday Sand and Gravel Co. in Wyandotte County; Rithie Sand Co. in Sedgwick County; Bingham Sand and Gravel Co. in Cherokee County; Builders Sand Co. in Johnson and Wyandotte Counties; and Miles Sand Inc. in Sedgwick County. Of the sand and gravel sold or used in 1977, 79% of the production and value came from commercial sources; the remainder was supplied from government and contractor operations. The major uses by quantity were concrete aggregate 34%, roadbases 24%, fill 16%, asphaltic concrete aggregate 12%, concrete products 8%, and other uses the remainder.

Table 8.—Kansas: Sand and gravel sold or used by producers, by county[1]

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Barber	2	W	W	2	W	W
Barton	7	364	413	7	786	1,184
Chase	1	9	3	--	--	--
Cherokee	2	W	W	3	W	W
Cheyenne	3	73	127	3	34	103
Clark	1	25	17	1	27	40
Clay	1	W	W	1	W	W
Cloud	1	169	W	1	W	W
Comanche	2	27	27	1	W	13
Cowley	3	125	175	3	554	915
Decatur	1	19	5	2	70	104
Dickinson	1	W	W	1	56	98
Doniphan	--	--	--	1	4	10
Douglas	2	W	W	1	W	W
Edwards	1	W	W	2	111	167
Elk	1	W	W	--	--	--
Ellis	3	131	229	4	130	256
Ellsworth	5	38	23	3	59	90
Finney	2	W	W	4	W	W
Ford	3	224	364	5	354	610
Geary	3	263	302	3	W	W
Gove	1	36	9	1	38	57
Graham	1	30	7	1	31	47
Grant	1	8	4	1	6	9
Gray	1	50	42	3	131	197
Greeley	1	6	3	--	--	--
Greenwood	1	W	W	--	--	--
Hamilton	2	23	34	3	36	111
Harper	2	W	W	2	111	167
Harvey	2	294	W	2	W	W
Haskell	1	48	16	2	94	140
Hodgeman	2	22	6	3	44	66
Jackson	--	--	--	1	W	29
Jewell	--	--	--	1	400	700
Johnson	1	W	W	2	W	W
Kearny	3	W	W	3	221	332

See footnotes at end of table.

Table 8.—Kansas: Sand and gravel sold or used by producers, by county[1] —Continued

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Kingman	2	W	W	1	32	48
Kiowa	2	W	W	2	180	298
Lane	1	65	16	--	--	--
Lincoln	1	W	W	1	132	199
Lyon	1	19	6	1	20	30
McPheron	1	5	3	1	5	7
Marshall	2	164	366	2	138	333
Meade	1	31	31	1	37	55
Mitchell	2	27	26	--	--	--
Morris	1	W	W	--	--	--
Morton	1	7	10	1	7	11
Neosho	2	W	W	1	W	W
Ness	1	81	90	1	87	130
Norton	1	W	25	1	19	28
Ottawa	1	17	5	1	18	27
Pawnee	4	150	203	3	90	164
Phillips	2	65	63	1	20	28
Pottawatomie	1	80	142	1	118	218
Pratt	2	W	W	2	W	W
Rawlins	3	9	7	3	27	40
Reno	7	647	720	6	695	1,161
Republic	1	W	W	1	W	W
Rice	3	W	W	3	W	W
Riley	2	W	W	1	W	W
Rooks	1	15	4	1	16	24
Russell	1	54	50	1	63	95
Saline	3	W	W	4	266	587
Scott	--	--	--	1	10	15
Sedgwick	12	2,634	3,127	13	2,419	4,235
Seward	3	142	194	4	W	W
Shawnee	7	612	679	9	624	1,014
Sheridan	1	15	4	2	65	102
Sherman	4	32	16	3	63	101
Stafford	1	W	W	1	50	75
Stevens	1	82	83	1	42	W
Sumner	1	W	W	1	W	W
Thomas	4	115	112	5	163	253
Trego	2	143	126	3	155	238
Wallace	1	7	10	1	16	24
Washington	1	W	W	1	W	W
Wichita	2	W	W	1	22	33
Wyandotte	8	1,538	2,414	8	1,881	2,989
Other counties	2	3,549	4,597	--	3,200	5,290
Total[2]	164	12,291	14,940	168	13,973	23,299

W Withheld to avoid disclosing company proprietary data; included with "Other counties."

[1] Excludes industrial sand and gravel.

[2] Data may not add to totals shown because of independent rounding.

Table 9.—Kansas: Sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:[1]				
Sand	9,511	11,205	9,184	15,217
Gravel	2,780	3,735	4,789	8,082
Total	12,291	14,940	13,973	23,299
Industrial sand and gravel	W	W	W	W

W Withheld to avoid disclosing company proprietary data.

[1] Construction sand and gravel includes unprocessed sand and gravel.

Table 10.—Kansas: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	4,718	6,444	4,732	8,929
Concrete products	443	560	1,150	2,549
Asphaltic concrete	1,735	2,334	1,698	3,020
Roadbase and coverings	2,342	2,321	3,388	5,296
Fill	1,689	1,932	2,302	2,443
Other uses	1,363	1,347	703	1,063
Total[1]	12,291	14,940	13,973	23,299

[1] Data may not add to totals shown because of independent rounding.

Stone.—During 1977, 59 companies and Federal and State agencies operated 184 quarries in the State. Production of crushed stone totaled 17.2 million tons valued at $41.8 million, increases of 5% and 9%, respectively, from the 1976 figures. Output of crushed stone (limestone and sandstone) was used for cement manufacture, roadstone, concrete aggregate, roadbase aggregate, bituminous aggregate, and other uses. Leading crushed stone producers were Martin-Marietta Aggregates (Central Division), Ashland Oil and Refining Co. (Reno Construction Co.), and Ash Grove Cement Co. H. J. Born Stone Co., Inc., and Bayer Stone Inc. quarried dimension limestone at five quarries for cut building stone, house stone veneer, and sawed building stone.

Among the States, Kansas ranked 22d in the output of crushed stone and 5th in the production of dimension limestone.

Table 11.—Kansas: Stone sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Kind of stone	1976		1977	
	Quantity	Value	Quantity	Value
Dimension stone: Total	W	W	W	W
Crushed and broken stone:				
Limestone	15,734	36,331	16,761	40,325
Undistributed[1]	614	1,897	468	1,481
Total	16,348	38,228	17,229	41,807

W Withheld to avoid disclosing company proprietary data.

[1] Includes sandstone, quartzite, and other stone.

Table 12.—Kansas: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Cement manufacture	3,317	6,293	3,328	6,196
Roadstone	2,549	5,098	3,265	7,421
Concrete aggregate	2,722	8,404	2,874	9,081
Dense-graded roadbase stone	2,665	5,990	2,812	6,343
Bituminous aggregate	2,167	5,527	2,387	6,453
Surface treatment aggregate	1,222	3,271	1,140	3,184
Agricultural limestone	864	1,673	430	897
Macadam aggregate	236	362	308	431
Railroad ballast	W	W	215	645
Riprap and jetty stone	158	363	150	414
Filter stone	W	W	78	222
Other uses[2]	448	1,247	241	519
Total[3]	16,348	38,228	17,229	41,807

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, sandstone, and miscellaneous stone (1976).

[2] Includes stone used in fill (1977), terrazzo and exposed aggregate (1977), and uses indicated by symbol W .

[3] Data may not add to totals shown because of independent rounding.

Sulfur.—Elemental sulfur was recovered as a byproduct of crude petroleum refining by CRA, Inc., Montgomery County; Phillips Petroleum Co., Wyandotte County; and Skelly Oil Co., Butler County. Sales of 4,723 long tons valued at $156,991 in 1977 were down 33% in quantity and 37% in value from sales in 1976.

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[1] State Liaison Officer, Bureau of Mines, Topeka, Kans.

[2] Mineral economist, State Geological Survey of Kansas, Lawrence, Kans.

[3] Grisafe, D. A. Kansas Building Limestones. Kansas Geological Survey Mineral Resource Series 4, 1977, 42 pp.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co.[1] [2]	1000 Ten Main Center Kansas City, MO 64105	Plant and quarry	Neosho.
Victor Div., General Portland, Inc.[2]	7701 East Kellogg St., Wichita, KS 67207	do	Wilson.
Lone Star Industries, Inc.[2]	2511 East 46th St. Indianapolis, IN 46205	do	Wyandotte.
The Monarch Cement Co.[1] [2]	Humboldt, KS 66748	do	Allen.
Universal Atlas Cement Div., United States Steel Corp.[1] [2]	600 Grant St. Pittsburgh, PA 15230	do	Montgomery.
Clays:			
Acme Brick Co., Division of Justin Industries, Inc.	Box 425 Fort Worth, TX 76101	Mines and plants	Cherokee and Ellsworth.
Cloud Ceramics	Box 98 Concordia, KS 66901	Mines and plant	Cloud.
W. S. Dickey Clay Manufacturing Co	Box 6 Pittsburg, KS 66762	Pits and plant	Cherokee and Crawford.
Excelsior Brick Corp	Box 32 Fredonia, KS 66736	do	Wilson.
Micro-Lite, Inc	1100 South Katy St. Chaute, KS 66720	Pit	Neosho.
Gypsum:			
Georgia-Pacific Corp	900 SW. 5th Ave. Portland, OR 97204	Mine and plant	Marshall.
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	do	Barber.
Helium:			
Alamo Chemical Co	Ashfield, KS 67953	Plant	Morton.
Cities Service Cryogenics, Inc	Scott City, KS 67871	do	Scott.
Kansas Refined Helium Co	Otis, KS 67565	do	Rush.
Northern Helex Co	Bushton, KS 67427	do	Rice.
Lime:			
The Great Western Sugar Co	Box 5308 Denver, CO 80217	do	Sherman.
Perlite, expanded:			
Lite Weight Products, Inc	707 Funston Rd. Kansas City, KS 66115	do	Wyandotte.
Salt:			
American Salt Corp	3142 Broadway Kansas City, MO 64111	Wells and underground mine.	Rice.
Carey Salt Co., Division of Interpace Corp.	1800 Carey Blvd. Hutchison, KS 67501	do	Reno.
Morton Salt Co	110 North Wacker Dr. Chicago, IL 60606	Wells	Do.
Chemical Div., Vulcan Materials Co	Box 7689 Birmingham, AL 35223	do	Sedgwick.
Sand and gravel:			
Bingham Sand and Gravel Co	2005 East Ave. Baxter Springs, KS 66713	Pits and plants	Cherokee.
Builders Sand Co	78th & Holliday Dr. Kansas City, KS 66106	Dredge and plant	Johnson and Wyandotte.
Holliday Sand and Gravel Co	6811 West 63 St. Overland Park, KS 66202	Dredges	Wyandotte.
Miles Sand Inc	4857 North Meridian Wichita, KS 67204	Pit and plant	Sedgwick.
Ritchie Sand Co	6500 West 21st St. Wichita, KS 67204	Dredge	Do.
J. H. Shears & Sons, Inc	819 West 1st St. Hutchison, KS 67501	Pit and plant	Reno.

See footnotes at end of table.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
N. R. Hamm Quarries, Inc	Box 425 Herington, KS 67449	Quarries and plants	Various (16 counties).
Holland Quarries, Inc	Box 5283 Lenexa, KS 66215	Mines and plants	Johnson.
Killough-Clark, Inc	Box 623 Ottawa, KS 66067	Quarries and plants	Anderson, Douglas, Franklin, Miami, Osage.
Martin-Marietta Corp	11300 Rockville Pike Rockville, MD 20852	do	Various (17 counties).
Midwest Minerals, Inc	709 North Locust Pittsburg, KS 66762	do	Cherokee, Crawford, Labette, Montgomery, Neosho, Wilson.
Reno Construction Co., Inc	Box 4278 Overland Park, KS 66204	do	Johnson, Miami.
Sulfur (byproduct):			
CRA, Inc	3315 North Oak Trafficway Kansas City, MO 64116	Secondary recovery	Montgomery.
Phillips Petroleum Co	Bartlesville, OK 74003	do	Wyandotte.
Skelly Oil Co	Box 1650 Tulsa, OK 74101	do	Butler.

[1] Also clays.
[2] Also stone.

The Mineral Industry of Kentucky

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Kentucky for collecting and disseminating information on all minerals produced from mines, quarries and wells.

By William T. Boyd[1] and Preston McGrain[2]

The total value of mineral production in Kentucky increased 3% in 1977 to $3.2 billion despite lengthy "wildcat" strikes, erratic markets for metallurgical coal, and declining petroleum production. This increase reflected the State's continuing first place in bituminous coal production, and increases in production and value of cement, lime, stone, and sand and gravel. During 1977, the coal industry produced a record total of 143.3 million tons valued at more than $2.9 billion.

During the past 5 years, the total value of Kentucky's mineral production has almost tripled, largely because of continuing national energy problems and the resultant increases in the unit values of fossil fuels. Eleven mineral commodities were produced in 1977, 4 were fossil fuels and 7 were nonmetals or industrial minerals. The fuels accounted for 95% of the total value of all minerals produced in 1977. The continuing improvement in the construction and housing industries resulted in a slight increase in the production of sand and gravel along with construction stone, and the value of these resources increased about $16.3 million in 1977.

Table 1.—Mineral production in Kentucky[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] ---------- thousand short tons--	754	$2,395	716	$2,500
Coal (bituminous) -------------do----	143,972	2,848,690	146,262	2,928,678
Natural gas ---------million cubic feet--	66,137	36,375	60,902	33,496
Petroleum--- thousand 42-gallon barrels--	7,483	85,454	6,581	85,659
Sand and gravel --- thousand short tons--	9,154	15,271	9,764	19,686
Stone (crushed)-----------------do----	33,378	77,060	36,096	88,941
Zinc------------------short tons--	59	44	--	--
Combined value of cement (portland and masonry), ball clay, fluorspar, lime, and natural gas liquids ---------------	XX	49,300	XX	58,900
Total------------------------	XX	3,114,589	XX	3,217,860
Total 1967 constant dollars ---------	XX	1,119,695	XX	[p]1,528,336

[p]Preliminary. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure.
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes ball clay; value included in "Combined value" figure.

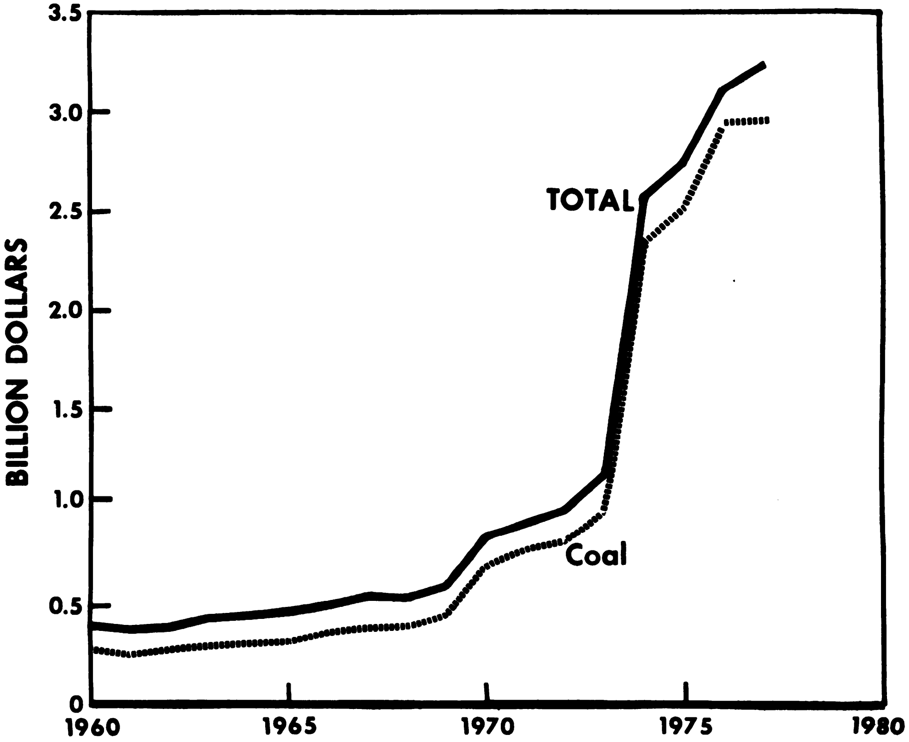

Figure 1.—Value of coal and total value of mineral production in Kentucky.

Table 2.—Value of mineral production in Kentucky, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adair	W	W	Stone.
Allen	W	W	Do.
Anderson	W	W	Do.
Ballard	$2	$4	Sand and gravel.
Barren	W	W	Stone.
Bell	W	--	
Boone	W	W	Sand and gravel, stone.
Bourbon	W	W	Stone.
Boyd	W	--	
Boyle	W	W	Stone.
Breathitt	W	--	
Breckinridge	W	W	Stone, sand and gravel.
Bullitt	W	W	Stone, clays.
Butler	W	W	Stone.
Caldwell	W	W	Stone.
Calloway	W	123	Sand and gravel.
Carlisle	W	W	Clays, sand and gravel.
Carter	W	W	Stone, clays.
Casey	W	W	Stone.
Christian	W	2,658	Do.
Clay	W	--	
Clinton	W	W	Stone.
Crittenden	W	W	Fluorspar, stone.
Cumberland	W	W	Stone.
Davies	W	2,005	Sand and gravel.
Edmonson	W	W	Stone.
Elliott	W	--	
Estill	W	316	Stone.
Fayette	W	W	Do.
Fleming	W	W	Do.
Floyd	113,785	W	Sand and gravel.
Franklin	W	W	Stone.
Fulton	W	140	Sand and gravel.
Gallatin	192	297	Do.
Garrard	W	W	Stone.
Graves	W	W	Clays, sand and gravel.
Grayson	W	W	Stone.
Green	W	W	Do.
Greenup	W	--	
Hancock	3,977	W	Sand and gravel, clays.
Hardin	1,863	2,493	Stone.
Harlan	W	791	Do.
Harrison	W	W	Stone.
Hart	W	W	Sand and gravel, stone.
Henderson	W	378	Sand and gravel..
Henry	W	W	Stone.
Hickman	W	W	Sand and gravel.
Hopkins	W	--	
Jackson	W	232	Stone.
Jefferson	W	27,855	Cement, stone, sand and gravel, clays.
Jessamine	W	W	Stone.
Johnson	W	--	
Knott	W	--	
Knox	W	--	
Laurel	W	95	Stone.
Lawrence	W	--	
Lee	W	W	Stone.
Leslie	W	--	
Letcher	W	3,209	Stone.
Lewis	W	W	Sand and gravel.
Livingston	W	21,043	Stone, sand and gravel.
Logan	W	W	Stone.
McCracken	W	263	Sand and gravel.
McCreary	W	--	
McLean	W	--	
Madison	W	W	Stone.
Magoffin	W	--	
Marion	W	198	Stone.
Marshall	4,061	--	
Martin	W	500	Sand and gravel.
Mason	W	W	Lime, stone, sand and gravel.
Meade	W	W	Stone.
Menifee	W	W	Do.
Mercer	W	W	Do.
Metcalfe	W	246	Do.
Monroe	W	359	Do.
Montgomery	W	W	Do.
Morgan	W	W	Do.
Muhlenberg	W	W	Do.
Nelson	W	W	Do.
Nicholas	505	326	Do.

See footnotes at end of table.

Table 2.—Value of mineral production in Kentucky, by county[1] [2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Ohio	W	W	Stone.
Oldham	W	$2,949	Stone, sand and gravel.
Owsley	W	--	
Pendleton	W	W	Lime, stone.
Perry	W	--	
Pike	W	W	Stone.
Powell	W	617	Stone, clays.
Pulaski	W	1,720	Stone.
Rockcastle	W	W	Do.
Rowan	W	W	Do.
Russell	W	--	
Scott	W	W	Stone.
Simpson	W	W	Do.
Spencer	W	W	Sand and gravel.
Taylor	W	W	Stone.
Todd	W	W	Do.
Trigg	W	W	Do.
Trimble	W	1,922	Sand and gravel.
Union	W	W	Do.
Warren	W	W	Stone.
Washington	W	W	Do.
Wayne	W	W	Stone, sand and gravel.
Webster	W	--	
Whitley	W	--	
Wolfe	W	W	Stone.
Undistributed[3]	$2,990,204	3,147,117	
Total[4]	3,114,589	3,217,860	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Bath, Bracken, Campbell, Carroll, Clark, Grant, Kenton, Larue, Lincoln, Lyon, Owen, Robertson, Shelby, and Woodford.

[2] Values of petroleum and natural gas are based on an average unit value for the State.

[3] Includes natural gas, natural gas liquids, petroleum, and coal (1977) and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Kentucky business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ... thousands	1,450.0	1,509.0	+4.1
Unemployment ... do	81.0	70.0	-13.6
Employment (nonagricultural):			
Mining ... do	46.8	48.0	+2.6
Manufacturing ... do	273.3	283.2	+3.6
Contract construction ... do	54.2	60.4	+11.4
Transportation and public utilities ... do	60.9	64.2	+5.4
Wholesale and retail trade ... do	234.1	247.5	+5.7
Finance, insurance, real estate ... do	43.4	46.5	+7.1
Services ... do	177.4	184.7	+4.1
Government ... do	221.6	222.7	+.5
Total nonagricultural employment ... do	1,111.7	1,157.2	+4.1
Personal income:			
Total ... millions	$18,600	$20,561	+10.5
Per capita	5,414	5,945	+9.8
Construction activity:			
Number of private and public residential units authorized	13,402	17,960	+34.0
Value of nonresidential construction ... millions	$186.8	$221.6	+18.6
Value of State road contract awards ... do	$183.0	$371.0	+102.7
Shipments of portland and masonry cement to and within the State thousand short tons	1,164	1,284	+10.3
Mineral production value:			
Total crude mineral value ... millions	$3,114.6	$3,217.9	+3.3
Value per capita, resident population	$909	$931	+2.4
Value per square mile	$77,103	$79,660	+3.3

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Legislation and Government Programs.—The U.S. Geological Survey, in cooperation with the Kentucky Geological Survey, completed a comprehensive statewide geologic mapping program for developing 7.5-minute quadrangle maps for all 120 counties. This intensive, complicated program required nearly 600 worker-years of technical effort. The resulting maps and technical data regarding mineral sampling locations and analysis will be especially useful to the mineral industries and other interested organizations for assessing the productive potential and optimum transportation route for new mining operations in selected mineralized areas.

The Bureau of Mines continued a cooperative study with Morehead State University for devising new techniques to relate geologic surface fractures with severe stress conditions in underground mine workings. Earlier conclusions regarding changing the orientation of mine workings to avoid these highly stressed areas was substantiated by underground tests, and then the study was broadened to devise a regional stress correlation with premining geologic conditions.

The University of Kentucky cooperated with the Leeco Corp. in developing pressure measuring instruments and installation techniques to measure stress conditions around a longwall face in thin coalbeds and then devise means for relating these measurements with roof control and mining conditions during actual coal extraction operations in thin coalbeds. The University of Kentucky obtained U.S. Department of Energy (DOE) funding for two research investigations to determine the extent and quantity of Devonian shale deposits within the State for the production of natural gas, and for determining relationships between the gas emission rates and the location, size and extent of geologic fractures within these vast shale formations.

DOE approved funding for construction of three small coal gasification plants within the State, but recent actions by citizens' groups may prevent the final construction of one coal gasification plant proposed for the Georgetown area.

The Environmental Protection Agency (EPA) continued financial support of studies to evaluate the erosion control characteristics of certain materials used for construction of surface mine roadways, and for assessing the environmental problems created by nearby surface mining operations. Actions by EPA regarding the present and future disposal of solid mine wastes have caused much concern within the Eastern and Western coalfields. It is possible that increasing restrictions on placement and drainage control may soon prohibit the surface disposal of these waste products. During the past 5 years, the State has supported research for determining possible optimum use of vast quantities of these materials, including the development of lightweight aggregate road-paving compounds and of new mining technology permitting the placement and solidification of these products in underground mine openings to increase roof control and increase coal recovery.

The Tennessee Valley (TVA) Authority supported a $6.2 million program for reclaiming 27,000 acres of abandoned, stripped coal land in a 12-county area in eastern Kentucky and authorized the expenditure of $40 million for a planned $150 million coal preparation facility at the Paradise power plant that will process 2,000 tons per hour of delivered coal. During the past 7 years, TVA has paid western Kentucky farmers nearly $400,000 for sulfur dioxide damages to crops planted near the Shawnee 1.5 megawatt coal-burning powerplant. Two 800-foot smokestacks were completed in 1977 to replace the 250-foot stacks at this plant, and the new stacks should reduce emission damages to nearby croplands.

The National Aeronautics and Space Administration funded a basic research project for determining the practicability of using satellite-collected data for delineating surface disturbances and, if possible, detecting unauthorized strip coal mining operations.

The State made extensive changes in the Executive Branch to increase the professionalism in the enforcement of surface coal mining regulations; established an Energy Department to coordinate the energy research efforts of various State agencies; and constructed an energy laboratory for developing and evaluating new coal utilization technologies, including coal gasification and liquefaction. The State legislature had previously appropriated $50 million to be used partially as matching funds for Federal cooperative, energy-related studies. The University of Kentucky organized an Institute of Mining and Minerals Research that will conduct Federal-State contract research on the extraction, transportation, and utilization of fossil fuels and other minerals.

The Kentucky Department of Mines and Minerals instituted a mandatory training program for coal mining operations requiring 48 hours of preentry training for new workers and an 8-hour annual refresher training session for all workers. The Federally funded program for training emergency medical technicians continued at several colleges, and the State continued recruiting personnel for the 100-person safety analyst group that will visit active mining operations, note unsafe work habits, and then work with individual miners to improve personal safety.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—The spot market and metallurgical coal markets were erratic during the year, and the lengthy strike by the United Mine Workers of America (UMWA) created unstable mining conditions in the State. These handicaps, however, did not prevent the coal industry from reaching a record production of 146.3 million tons, a 1.6% increase over 1976. The value of this production reached a record total of $2.9 billion for an average value of $20.02 per ton compared with $19.79 in 1976. During 1977, the number of mines increased 9.3% and the number of employees increased 14.6% over that of 1976. Coal was produced from 46 counties, and Pike and Muhlenberg Counties continued to lead in production by producing 17.9 and 17.3 million tons, respectively.

Surface mining continued as the leading production method employing 26,817 workers at 1,775 mines and accounting for 56% of the total output. The 1,536 underground mines employed 29,925 workers and accounted for 44% of output.

The other fuels—natural gas and petroleum—both showed decreased output with slight increases in unit values. Petroleum was produced from 56 counties, but 21 of these counties produced less than 10,000 barrels, indicating continuing production from older stripper wells.

NONMETALS

Cement.—The cement plant of The Flintkote Co., in Jefferson County, produced cement during the year. Most of the portland cement from this plant was used for highway construction, for building materials, and by concrete products manufacturers.

Clays.—Clay production decreased slightly during the year. Unit values however, increased. Ball and fire clays were processed, packaged, and shipped in bulk to manufacturers of pottery ware, floor and wall tile, refractory and fire brick, and for use as paper filler.

Fluorspar.—Frontier Spar Corporation operated a mine and mill near Salem, and Kenspar Co. operated a small flotation plant in southern Crittenden County, near Mexico.

Graphite.—Superior Graphite Co. and The Carborundum Co. produced synthetic graphite in Christian and Fulton Counties for electrodes, foundry facing, and steelmaking purposes.

Perlite and Vermiculite.—Two companies having operations in Boone and Campbell Counties imported ores and produced expanded perlite and vermiculite primarily for roof insulation, construction, and agricultural purposes.

Sand and Gravel.—Thirty-six sand and gravel operations produced a total of 9.7 million tons valued at $19.7 million. The bulk of this production was used for cement aggregate, roadway, construction, and foundry purposes.

Stone.—Sixty companies operating 111 quarries produced nearly 36.1 million tons of stone valued at $88.9 million. Most of the stone was used for highways, railroad, and construction purposes with a small quantity being used for agricultural lime and in the expanding markets of sulfur dioxide removal at coal-burning powerplants. The Black River Mining Co., Pendleton County, produced quicklime for steel furnaces and lime dust for allaying coal mine dust. The Dravo Lime Co., a subsidiary of Dravo Corp., dedicated a $60 million underground limestone mine and plant in Mason County for producing lime used primarily for SO_2 removal purposes by coal-burning thermal powerplants.

Table 4.—Kentucky: Sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	7,117	11,092	7,622	14,556
Gravel	1,995	3,897	2,082	4,535
Total[1]	9,111	14,989	9,704	19,091
Industrial sand	43	282	61	595
Grand total[1]	9,154	15,271	9,764	19,686

[1] Data may not add to totals shown because of independent rounding.

Table 5.—Kentucky: Construction sand and gravel sold or used, by major use category

Use	1976		1977[1]		
	Quantity (thousand short tons)	Value (thousands)	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	4,232	$6,696	4,828	$10,123	$2.10
Concrete products (cement blocks, bricks, pipe, etc.)	1,366	1,980	908	2,362	2.60
Asphaltic concrete aggregates and other bituminous mixtures	2,736	5,185	1,756	3,497	1.99
Roadbase and coverings	221	320	446	741	1.66
Fill	474	658	1,715	2,209	1.29
Railroad ballast	--	--	W	W	1.96
Other uses	82	150	50	162	3.24
Total or average	9,111	14,989	9,704	19,091	1.97

W Withheld to avoid disclosing company proprietary data; included in "Other uses."
[1] Data may not add to totals shown because of independent rounding.

METALS

Armco Steel Corp. produced small quantities of both pig iron and iron oxide pigments at its Ashland plant in Boyd County.

The National Southwire Aluminum Co. continued operations at Hawesville, in Hancock County.

Mineral exploration in north-central Tennessee has created renewed interest in developing zinc mining operations in south-central Kentucky. One company has already drilled an 8-foot-diameter, 2,000-foot-deep vertical shaft and is now engaged in sampling operations from the bottom of the shaft.

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[1] State Liaison Officer, Bureau of Mines, Frankfurt, Ky.

[2] Assistant state geologist, Geological Survey of Kentucky, University of Kentucky, Lexington, Ky.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum, primary:			
The Anaconda Company, Anaconda Aluminum.	Box 44 Henderson, KY 42420	Smelter	Henderson.
Barmet of Kentucky, Inc	Box 98 Utica, KY 42376	do	Daviess.
National Aluminum, Div. of National Steel Corp.	Box 385 Hawesville, KY 42348	do	Hancock.
National-Southwire Aluminum Co	Box M Hawesville, KY 42348	do	Do.
Ohio Valley Aluminum Co	Industrial Park Shelbyville, KY 40065	do	Shelby.
Cement:			
The Flintkote Co	Kosmosdale, KY 40272	Plant	Jefferson.
Clays:			
American Olean Tile Co	Lewisport, KY 42351	Mines	Hancock.
Cline Brick Co	Box 1790 Ashland, KY 41101	Mine	Boyd.
Corbin Brick Co	Box 452 Corbin, KY 40701	do	Whitley.
Kentucky-Tennessee Clay Co	Box 77 Mayfield, KY 42066	Mines and plants	Graves.
Old Hickory Clay Co	Mayfield, KY 42066	Mines	Do.
Owensboro Brick & Tile	Ewing Road, Box 708 Owensboro, KY 42301	Mine	Hancock.
H. B. Sipple Brick Co	Box 35 Stanton, KY 40380	do	Powell.
Coal:			
Amax Coal Co	150 South Meridan St. Indianapolis, IN 46225	Strip mine	Muhlenberg.
Beth-Elkhorn Corp	701 East Third St. Bethlehem, PA 18016	Underground mines	Letcher and Pike.
Gibraltar Coal Co	150 South Meridan St. Indianapolis, IN 46225	Mines	Muhlenberg.
Island Creek Co	Wheelwright, KY 41669	do	Various.
Peabody Coal Co	301 North Memorial Dr. St. Louis, MO 63102	Underground and strip mines.	Muhlenberg, Ohio, Union.
Pittsburg & Midway Coal Mining Co.	10 Main Center Kansas City, MO 64105	do	Hopkins and Muhlenberg.
United States Steel Corp	525 William Penn Pl. Pittsburgh, PA 15230	Mines	Harlan.
Coke:			
Allied Chemical Corp	Ashland, KY 41101	Plant	Boyd.
Ferroalloys:			
Airco Alloys Div., Airco, Inc	Box 217 Calvert City, KY 42029	do	Marshall.
Fluorspar:			
Frontier Spar Corp	Box 305 Calvert City, KY 42029	Underground mine	Crittenden.
Graphite:			
The Carborundum Co	Hickman, KY 42050	Plant	Fulton.
Iron (pig):			
Armco Steel Corp	Box 191 Ashland, KY 41101	Mill	Boyd.
Interlake, Inc	9th & Lowell St. Newport, KY 41071	Mill	Campbell.
Lime:			
Black River Mining Co	Route 1 Butler, KY 41006	Mine and plant	Pendleton.
Natural gas:			
Columbia Gas Transmission	1700 MacCorkle, SE. Charleston, WV 25325	do	Do.
Inland Gas Co	340 17th St. Ashland, KY 41101	Natural gas wells	Various.
Kentucky-West Virginia Gas Co	Second National Bank Bldg. Ashland, KY 41101	do	Do.
Texas Gas Transmission Co	3800 Frederica St. Owensboro, KY 42301	do	Do.
Wiser Oil	Box 192 Sistersville, WV 26175	do	Do.
Perlite (expanded):			
W. R. Grace & Co	112 North St. Newport, KY 41071	Plant	Campbell.
Grefco, Inc	7125 Industrial Rd. Florence, KY 41042	do	Boone.
Petroleum:			
Ashland Oil & Refining Co	1409 Winchester Ave. Ashland, KY 41101	Wells and refinery	Various.
Har-Ken Oil Co	Box 616 Owensboro, KY 42301	Wells	Do.
Exxon Company USA	Box 367 Memphis, TN 48101	do	Do.
Sun Oil Co	Box 296 Centerville, OH 45459	do	Do.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Ingram Materials, Inc	Box 684 Calvert City, KY 42029	Dredge	Livingston.
Martin Marietta Corp	Burlington, KY 41005	do	Various.
Nugent Sand Co	Box 6072 Louisville, KY 40206	do	Jefferson.
E. T. Slider Co., Inc	Box 6041 Louisville, KY 40206	Pit	Do.
Stone:			
Kentucky Stone Co	400 Sherburn Lane Louisville, KY 40207	Mines, quarries, plants.	Various.
Martin Marietta Corp	Box 91007 Fern Creek, KY 40291	Quarries, plants	Jefferson.
Reed Crushed Stone Co., Inc	Box 35 Gilbertsville, KY 42044	Quarry, plant	Livingston.
Three Rivers Rock Co., Inc	Box 218 Smithland, KY 42081	Quarries	Do.
Vulcan Materials Corp	Box 19008 Louisville, KY 40200	Quarries and mine	Various.
Vermiculite, exfoliated:			
W. R. Grace & Co	112 North St. Newport, KY 41071	Plant	Campbell.

The Mineral Industry of Louisiana

By Owen W. Jones[1] and Harry L. Roland[2]

In 1977 Louisiana maintained its ranking as second in the Nation in value of mineral production for the 20th consecutive year. Production of crude minerals was valued at $10.9 billion, or about 14% of the U.S. total. This was an increase of 26% over the 1976 value and a new record. Value of mineral production amounted to $224,881 per square mile of State area — a figure approached by only West Virginia at $132,669. The State ranked first in the Nation in natural gas production and salt production, and second in petroleum, natural gas liquids, and Frasch sulfur production. These commodities are important to industry and agriculture both in the United States and worldwide. In addition, important quantities of alumina, metallic aluminum, nickel, cobalt, and copper were refined from imported ores. Most of the individual commodities were either produced in approximately the same or smaller quantities than in 1976. Natural gas production showed an appreciable increase both in quantity and in value.

The economic impact of the State's mineral production is much greater than the crude mineral production value. The industry of the State is largely dependent on mineral production, either for fuel or raw material. In the years 1976-77, capital investment in mineral-related industries was $2.3 billion, according to the Louisiana Department of Commerce and Industry. At the end of 1977, mining and quarrying employment in Louisiana was approximately 66,100 workers earning a total $1.1 billion. In addition, approximately 53,000 mineral manufacturing employees earned $946 million.

Louisiana ranked 15th in the United States in value of industry shipments (a useful measure of manufacturing activity), according to the Census of Manufacturers — U.S. Bureau of the Census. During the period 1963-75 (the latest data available), this value increased at an average rate of 14% per year. The estimated total value of industry shipments in 1977, based on this rate of growth, was $29.2 billion. Nearly two-thirds of this came from four mineral-related industries: Chemical and Allied Products, Petroleum and Coal Products, Stone, Clay and Glass Products, and Primary Metal Industries.

Table 1.—Mineral production in Louisiana[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Clays ________ thousand short tons	513	$1,158	401	$785
Natural gas ________ million cubic feet	7,006,596	3,223,034	7,215,006	5,068,295
Natural gas liquids:				
Natural gasoline and cycle products ______ thousand 42-gallon barrels	27,078	151,683	117,763	804,183
LP gases ________ do	91,701	375,057		
Petroleum (crude) ________ do	606,501	4,556,761	562,905	4,689,122

See footnotes at end of table.

Table 1.—Mineral production in Louisiana[1] —Continued

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Salt .... thousand short tons	13,491	$91,952	13,201	$96,878
Sand and gravel .... do	22,528	51,293	21,987	50,790
Stone (crushed) .... do	9,685	28,127	9,710	26,920
Sulfur (Frasch) .... thousand long tons	2,445	W	2,455	W
Combined value of cement (masonry and portland), gypsum, lime, and items indicated by symbol W	XX	173,042	XX	174,912
Total	XX	8,652,107	XX	10,911,885
Total 1967 constant dollars	XX	4,441,127	XX	[p]5,386,106

[p] Preliminary. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Louisiana, by parish[1]

(Thousands)

Parish	1976[r]	1977[2]	Minerals produced in 1977 in order of value
Acadia	W	NA	
Allen	W	W	Sand and gravel.
Ascension	W	W	Salt.
Assumption	$60,032	W	Do.
Avoyelles	5,297	NA	
Beauregard	W	W	Sand and gravel.
Bienville	23,724	W	Clays.
Bossier	36,683	NA	
Caddo	36,483	W	Clays.
Calcasieu	19,122	W	Salt, stone.
Caldwell	W	NA	
Cameron	W	W	Salt.
Catahoula	14,772	$738	Sand and gravel.
Claiborne	W	NA	
Concordia	22,964	NA	
DeSoto	17,921	NA	
East Baton Rouge	W	W	Sand and gravel, clays.
East Carroll	261	38	Sand and gravel.
East Feliciana	1,350	3,057	Do.
Evangeline	W	NA	
Franklin	2,309	NA	
Grant	2,177	3,125	Sand and gravel.
Iberia	495,556	W	Salt.
Iberville	68,379	W	Do.
Jefferson	W	W	Sulfur, salt.
Jefferson Davis	W	W	Sand and gravel.
Lafayette	W	460	Do.
Lafourche	583,167	W	Sulfur.
La Salle	33,700	980	Sand and gravel.
Lincoln	W	W	Clays.
Livingston	W	1,027	Sand and gravel.
Madison	W	W	Do.
Morehouse	W	W	Do.
Natchitoches	64,742	W	Clays, sand and gravel.
Orleans	W	W	Cement, stone, lime.
Ouachita	15,287	2,348	Sand and gravel.
Plaquemines	W	W	Sulfur, salt.
Pointe Coupee	32,458	W	Clays.
Rapides	4,836	3,992	Sand and gravel.
Red River	735	W	Do.
Richland	45,636	NA	
Sabine	1,311	W	Stone, sand and gravel.
St. Bernard	40,326	W	Sand and gravel.
St. Charles	W	NA	
St. Helena	W	W	Sand and gravel, clays.
St. James	W	NA	
St. Landry	51,738	NA	
St. Martin	101,246	W	Salt, sand and gravel, clays.
St. Mary	1,045,633	W	Salt, stone, lime.
St. Tammany	W	W	Stone, sand and gravel, clays.
Tangipahoa	2,980	2,711	Sand and gravel.
Tensas	5,017	NA	

See footnotes at end of table.

Table 2.—Value of mineral production in Louisiana, by parish[1] —Continued

(Thousands)

Parish	1976[r]	1977[2]	Minerals produced in 1977 in order of value
Terrebonne	$1,268,862	NA	
Union	W	$276	Sand and gravel.
Vermilion	W	413	Do.
Vernon	615	766	Do.
Washington	4,348	3,985	Do.
Webster	W	5,398	Do.
West Baton Rouge	8,035	NA	
West Feliciana	3,337	2,038	Sand and gravel.
Winn	W	W	Stone, gypsum, sand and gravel.
Undistributed[3]	4,531,068	10,880,536	
Total[4]	8,652,107	10,911,885	

[r] Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] No production was reported for Jackson, St. John the Baptist, and West Carroll Parishes.

[2] Value of natural gas, natural gas liquids, and petroleum by county were not available; included in "Undistributed" figure.

[3] Includes some petroleum, and natural gas for 1976 that cannot be assigned to specific parishes and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Louisiana business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,495.0	1,568.0	+4.9
Unemployment	do	102.0	109.0	+6.9
Employment (nonagricultural):				
Mining	do	62.5	65.3	+4.5
Manufacturing	do	195.4	201.5	+3.1
Contract construction	do	110.7	104.6	-5.5
Transportation and public utilities	do	102.0	101.3	-.7
Wholesale and retail trade	do	305.5	319.3	+4.5
Finance, insurance, real estate	do	62.6	64.6	+3.2
Services	do	222.7	222.9	--
Government	do	253.0	255.0	+.8
Total nonagricultural employment	do	1,314.4	1,334.5	+1.5
Personal income:				
Total	millions	$20,680	$23,187	+12.1
Per capita		$5,337	$5,913	+10.8
Construction activity:				
Number of private and public residential units authorized		17,148	26,365	+53.7
Value of nonresidential construction	millions	$294.1	$412.8	+40.4
Value of State road contract awards	do	$253.5	$280.9	+10.8
Shipments of portland and masonry cement to and within the State	thousand short tons	2,565	2,617	+2.0
Mineral production value:				
Total crude mineral value	millions	$8,652.1	$10,911.9	+26.1
Value per capita, resident population		$2,253	$2,783	+23.5
Value per square mile		$178,309	$224,881	+26.1

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

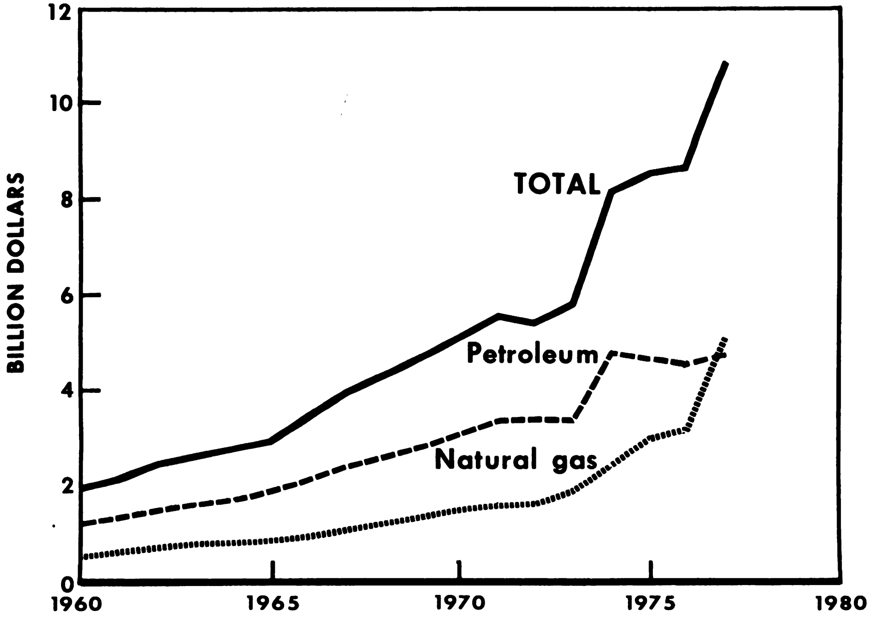

Figure 1.—Value of petroleum, natural gas, and total value of mineral production in Louisiana.

Trends and Developments.—Louisiana industry is almost entirely energy intensive, attracted to the State in years past by the abundance of low cost mineral fuels. Recently, however, the increasing cost of fuels, supply uncertainties, and national fuel usage priorities have forced a reassessment. To meet future electricity needs, the State's utilities are making long-term commitments to coal. With the exception of lignite, the State has no coal reserves and is faced with the problem of planning for transportation and distribution of large quantities of coal.

LOOP, Inc. (an acronym for Louisiana Offshore Oil Port), was the first organization in the United States to accept a federal license, issued by the Department of Transportation in 1977, for building a deepwater port. Construction got underway and the port is expected to be operational in 1980. The terminal will be located approximately 19 miles offshore in Lafourche Parish. The entire LOOP system will include 19 miles of offshore pipelines and 28 miles of pipeline through the onshore marshland to Clovelly salt dome underground storage cavities. A separately owned pipeline will transport oil from storage to the St. James terminus of a crude oil pipeline serving the Midwest and connecting or interconnecting with approximately 25% of the Nation's refining capacity.

The first phase of LOOP's operation will furnish a capacity of 1.4 million barrels of crude per day. A study by H. J. Kaiser Co., contracted by the Louisiana Offshore Terminal Authority, projected that employment gains in southeast Louisiana due to the LOOP operation (both from direct employment and from ancillary industry employment) would amount to 16,250 in 1980 and to 46,850 in 2010. An Arthur D. Little Company study projected that increased wage income due to refining and petrochemical-related activities plus ancillary industry development would amount to $168 million in 1980 and to $3.6 billion in 2010 (in terms of 1975 dollars).

Increased exploration due to higher prices resulted in an increased number of producing gas wells in 1977, and the 3-year production decline was halted, at least temporarily. Deep Cretaceous drilling, prompted by the False River gas find in 1975, is called by exploration geologists probably the most significant development along the Gulf Coast in recent years. Drilling is completed, underway, or planned along a belt stretching some 200 miles from Allen Parish northeast of Lake Charles to St. Bernard Parish southeast of New Orleans.

Louisiana's 10-year tax exemption law provides that any manufacturer building a new facility in Louisiana or expanding an established Louisiana facility is eligible to receive exemptions on ad valorem taxes on buildings and equipment from State, parish and local taxes for a period of 5 calendar years, renewable for an additional 5 years.

In 1977 the Louisiana Department of Commerce and Industry approved 10-year ad valorem tax exemptions for industrial developments totaling $2.3 billion. This amount represented 52 new plants ($1 billion) and 392 expansions of existing plants ($1.3 billion). The year 1977 was the first that investment in new plants alone surpassed $1 billion. Investment in mineral-related industrial categories accounted for 58% of the total investment. Six parishes had industrial investments totaling more than $100 million each. These were St. Charles — $624 million; Pointe Coupee — $592 million; West Baton Rouge — $215 million; Ouachita — $149 million; Iberville — $128 million; and East Baton Rouge — $109 million.

Legislation and Government Programs.—In August 1977 the U.S. Department of Energy initiated strategic oil storage in the West Hackberry salt dome. Another storage cavern was being prepared at Bayou Choctaw salt dome, and the Federal Government purchased the Morton Salt Co. mine at Weeks Island salt dome to be used for strategic oil storage.

Under a contract with the Department of Energy, Union Carbide Corp.'s Office of Waste Isolation began a study of Louisiana salt domes as possible federal storage sites for nuclear waste generated throughout the Nation.

A $3 million project financed by the Department of Energy was initiated late in the year to study the geothermal energy potential of the Louisiana and Texas gulf coast area. A drill site will be selected at a later date. Louisiana's prospective sites are in Cameron, Calcasieu, and Acadia Parishes.

More than $2.4 million in Federal coastal energy impact funds were approved for two Louisiana projects by the Office of Coastal Zone Management of the U.S. Department of Commerce. The Federal funds are provided to lessen the impact along Louisiana's coast resulting from oil and gas exploration in the Federal Outer Continental Shelf (OCS).

An OCS sale planning schedule for the Gulf of Mexico area was proposed by the Department of the Interior in August 1977. Planned Gulf of Mexico sales are as follows:

Sale	Date
45	April 1978.
65	October 1978 (eastern Gulf of Mexico).
51	December 1978.
58	July 1979.
62	August 1980.
66	September 1981.

In the area offshore from Louisiana, 97 tracts totaling 454,704 acres were leased for a total bonus of $813,991,004. Crude and condensate production from the Federal OCS Zone off Louisiana was 282.55 million barrels, or 65.7% of total offshore crude and condensate production — including Alaska, California, Louisiana, and Texas (Federal and State). Federal and State production from offshore Louisiana was 73.6% of total offshore production.

The Louisiana Legislature enacted several bills having an impact on the mineral industry of the State:

Act 193, which prohibits the storage or disposal of radioactive waste materials in salt domes within the State.

Act 561, which grants expropriation authority to the owners and operators of coal slurry pipelines.

Act 650, the Natural Gas Pricing Act of 1977, to be administered by the Commissioner of Conservation, in his position as the Assistant Secretary of the Office of Conservation in the Department of Natural Resources. The act authorizes the Commissioner to establish the minimum sale price for the first sale of the new natural gas by a producer, such minimum price to be not less than (a) the equivalent price of imported crude petroleum determined on a Btu basis in relation to the average refiner acquisition costs of imported crude petroleum, or (b) not less than the weighted average of the first sale of intrastate natural gas by producers of like kind and quantity pursuant to contracts entered into in Louisiana within the earliest 3 months of a 6-month period beginning with and including the month in which the sale or other transfer of ownership is to be completed. The act provides that whichever of these two methods produces the lowest price shall be the method used to determine the minimum price for purposes of the act.

Act 674, which provides for a right and cause of action for failure to supply natural gas as a result of compulsory reallocation or curtailment, such right to be vested in the former purchaser and/or recipient of the natural gas against the ultimate industrial user or users and/or the ultimate local distribution company to whom the natural gas was reallocated and which are knowing beneficiaries as a consequence of availing themselves of the use of such natural gas. The act establishes "long arm jurisdiction" over nonresident industrial users and local natural gas distribution companies not otherwise subject to the jurisdiction of the courts of Louisiana which are knowing beneficiaries. The act establishes damages due to the former purchaser and/or recipient to be the amount of loss that the purchaser sustains or the gain of which he or she has been deprived, or where applicable, the right to recover the cost of alternate fuel based upon the costs of such ultimate fuel suitably adjusted for loss of efficiency and increased maintenance costs, or where applicable, all reasonable costs of converting to any alternate fuel. The act establishes emergency procedures and exemptions.

Act 661, which authorizes the Commissioner of Conservation to promulgate and enforce rules and regulations relative to natural gas transmission pipeline safety, including requirements for the performance of periodic hydrostatic pressure tests to confirm or revise maximum allowable operating pressures.

HCR 298, which authorizes and requests the Department of Natural Resources to study the impact upon the State of mandatory conversion from natural gas to coal as an energy source and to study the economic impact of cross-shipping natural gas and coal interstate instead of allowing each region of the country to utilize its indigenous fuels.

The Louisiana Department of Natural Resources was created by consolidating the State Department of Conservation, the State Mineral Board, the Forestry Commission, the Louisiana Energy Commission, the Louisiana Coastal Commission, and the Caldwell Forest Reserve. The new department also assumed the duties of the Register of State Land Office and of the Louisiana Coastal Commission Advisory Committee. Under the reorganization plan, the department is responsible for the conservation, management, and development of water, minerals, timber, energy, and other resources. It also administers and supervises all State lands.

A State energy conservation plan was approved for implementation by the Federal Energy Administration in August. The goal is to reduce the State's projected energy consumption in 1980 by at least 5%. Federal funding for this project by the U.S. Department of Energy included $614,000 for 1977 projects and more than $1.6 million for 1978 projects.

Governor Edwards directed that any federal pipeline construction applications be directed through the Secretary, Department of Natural Resources. As part of the Strategic Petroleum Reserve Program, the Corps of Engineers is seeking right-of-way permits to construct two pipelines connecting the Weeks Island and Bayou Choctaw salt domes with the St. James transfer terminal on the Mississippi River. Both pipelines would cross the environmentally sensitive Atchafalaya Basin. The State is opposing the Federal pipeline plan until "we know exactly where they are going with this program and how they plan to go about it."

Louisiana held 10 lease sales in 1977. The State Mineral Board offered 446 tracts totaling 332,298 acres. They awarded 338 tracts totaling 144,193 acres for $20,391,944. In addition, mineral production from State-owned lands brought in $177,259,221 of royalties during the year. Crude and condensate production from the State-owned offshore area was 33.814 million barrels, or 10.7% of total offshore Louisiana production.

Environment.—LOOP, Inc., entered into an agreement near yearend with the Louisiana Department of Wildlife and Fisheries to do environmental monitoring to satisfy State and Federal license regulations. LOOP, Inc., also signed an agreement with the Louisiana State University Center for Wetland Resources to conduct supplementary studies of the port's pipeline route in order to assess possible effects on vegetation, alligators, and waterfowl. These studies will establish bases for comparison with data obtained during construction and operation of the facilities. Additionally, a salt dome permit hearing was held at yearend to discuss the LOOP plan to store upwards of 56 million barrels of LOOP oil in caverns in the Clovelly salt dome near Golden Meadow.

The 1977 International Oil Spill Conference was held in New Orleans in March. The conference was sponsored by the American Petroleum Institute, the Environmental Protection Agency, and the U.S. Coast Guard. The conference took no direct action, but served as a medium of exchange of information by experts on the subject. Oil spills are of particular interest in Louisiana because one-third of the Nation's oil spills, accounting for 38% of the total spillage, have occurred in the Gulf of Mexico, according to U.S. Coast Guard statistics.

Project Shorebird Conference was held in New Orleans to demonstrate to legislators from 15 coastal States how Louisiana uses space technology to collect coastal data. The legislators visited the National Aeronautics and Space Administration Computer Center at Slidell to view equipment used in these earth satellite studies. Louisiana's 4-year-old program provides important information on coastal zone management decisions and has aided in flood damage assessment and other projects especially important to Louisiana because the coastal zone is so large and poorly defined. Satellite information can also be used to provide information on pollutants and oil spills in the Gulf of Mexico.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels (petroleum, natural gas, natural gas liquids) provided 97% of the State's crude mineral value. For the first time, value of natural gas at $5.1 billion exceeded that of petroleum at $4.7 billion. Louisiana production accounted for 36% of the natural gas, 19% of the crude oil, and 20% of the natural gas liquids produced in the United States.

Mineral fuels production supplies essentially all of Louisiana's energy needs, provides feedstock for the extensive refining and chemical industries in the State, and results in substantial economic benefits in the form of production value, tax revenues, jobs, and related activities.

Carbon black production in 1977 totaled 1,219 million pounds, an increase of 18% over production in 1976.

Current statistical information on fuels, including coal, petroleum, and natural gas, is no longer available from the Bureau of Mines, but data on nonfuel mineral commodities is still being provided.

Before October 1, the Bureau collected and regularly published a variety of statistical data on fuel production and use, and released certain monthly and quarterly statistics by telephone in advance of their publication in Bureau periodicals. Now, that information has become the responsibility of the newly created Department of Energy, which absorbed the Bureau's fuels data collection and analysis functions in a Government reorganization.

NONMETALS

Nonmetals value increased by $4.7 million in 1977 to $350 million and comprised 3% of the State's total mineral value. With the exception of 1973, when there was a 2% decrease, nonmetallic minerals produced in the State have increased in value since the 1971 low of $221 million. Of the eight nonmetallic minerals produced in 1977, four increased in value and four decreased in value.

Barite.—Barite is vital to the petroleum industry, which uses about 90% of the world's annual production. As a major ingredient of drilling muds, barite is circulated in the rotary drilling of oil and gas wells to lubricate the drill stem, cool the drill bit, confine high formation pressures, and seal the walls of the hole. About 20 pounds of barite are used for every foot of hole drilled. (Probably more in Louisiana because of the deeper than average drilling and higher formation pressures.) The U.S. Geological Survey estimates that in the next 10 years oil and gas well drilling will amount to 1.64 billion feet.

Crude barite was not mined in Louisiana. Ore mined both domestically and abroad was shipped to Louisiana for processing. It was crushed and ground for use as a weighting material in well drilling muds. Three plants in Orleans Parish and one each in Assumption, Calcasieu, St. Martin, and Terrebonne Parishes ground a total of 815,376 short tons valued at $30.6 million.

Cement.—Louisiana Cement Co., a division of OKC Corp., and Lone Star Industries, Inc., both of New Orleans, produced and sold portland cement. Louisiana Cement Co. produced and sold masonry cement, and Lone Star sold masonry cement. Portland cement accounted for 98% of the total production. Ready-mix companies and highway and other contractors used two-thirds of the total portland cement production. Raw materials used in making portland cement included shell, limestone, clay, sand, gypsum, iron ore, fly ash, and calcium chloride. Both plants used natural gas in their kilns. Louisiana ranked 23d nationally in both production and value. Louisiana Cement used clam and oyster shell as its raw material; Lone Star used limestone from Alabama. Production was up approximately 10% over that of 1976.

Clay and Shale.—The State ranked 27th in clay production. The 1977 output was 401,000 short tons valued at $785,000, down from 513,000 tons valued at $1.2 million in 1976. Average unit value in 1977 was $1.96 per ton. Eight brick companies at nine plants, one lightweight aggregate company, and two cement companies mined clay. Principal producing parishes in descending order of production were Pointe Coupee, St. Helena, East Baton Rouge, Caddo, and Natchitoches. Clay output was consumed in the manufacture of lightweight aggregate, common brick, and face brick.

The Louisiana Geological Survey continued sampling Louisiana clays for testing and evaluation at the Bureau of Mines Metallurgy Research Center in Tuscaloosa, Ala. The testing program is authorized by a mineral evaluation agreement between the State and the Bureau of Mines. Past results have indicated that Louisiana has large supplies of good commercial-grade clays.

Table 4.—Louisiana: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1973	979	1,329
1974	770	1,425
1975	531	1,132
1976	513	1,158
1977	401	785

Gypsum.—Crude gypsum was mined from the anhydrite-gypsum caprock of the Winnfield intrusive salt dome 5 miles west of the town of Winnfield in Winn Parish. Output increased nearly 30% over that of 1976. The entire output was used as a retarder in portland cement. Unit price was 12% higher than in 1976. Gypsum was calcined by National Gypsum Co. at its Jefferson Parish plant and by United States Gypsum Co. at its Orleans Parish plant. Output was used in the manufacture of wallboard.

Lime.—Louisiana ranks 15th in lime production. Much of the lime was produced by chemical companies for their own use. Pelican State Div. of S. I. Lime Co. in St. Mary Parish and United States Gypsum Co. in Orleans Parish produced both quicklime and hydrated lime. Lime output was consumed principally at chemical plants, aluminum smelters, and water purification facilities.

Perlite.—Although not mined in Louisiana, perlite was expanded at three plants — American Perlite Products, Inc., in Caddo Parish, W. R. Grace & Co. in Orleans Parish, and Filter Media Co. of Louisiana, Inc., in St. John the Baptist Parish. The latter is one of the principal producers of filter materials. Principal uses were for filter aids and in concrete aggregate. Other uses included horticultural aggregate, plaster aggregate, and low-temperature insulation.

Salt.—Salt, sold or used, totaled 13.2 million tons valued at $96.9 million, or $7.34 per ton compared with 13.5 million tons valued at $92 million in 1976. These statistics indicate a 2% decrease in tonnage and a 5% increase in value.

Louisiana was the top ranked salt producer among the States and accounted for nearly 31% of the total U.S. output.

Production consisted of rock salt, brine, and evaporated salt. Fourteen companies mined salt at 16 operations in 10 parishes. Eleven operations produced brine, 3 produced both evaporated and rock salt, 2 produced rock salt only, and 1 produced evaporated salt only. Evaporated salt averaged $64.32 per ton; rock salt, $8.24; and brine salt, $4.04.

Salt mining, both by solution and by underground methods, has provided ideal storage space. The resource value of some deposits, especially the salt domes along the gulf coast, may be determined more by the possible storage capacity than the salt itself.

The Department of Energy (DOE), accelerated the strategic petroleum reserve program by advancing the target date for the underground storage of 500 million barrels of crude oil to yearend 1980, rather than 1982. Four Louisiana salt domes were determined to be environmentally acceptable for strategic storage. The four domes were West Hackberry in Cameron Parish, Bayou Choctaw in Iberville Parish, Weeks Island in Iberia Parish, and Cote Blanche Bay in St. Mary Parish. The LOOP superport consortium also planned to utilize Clovelly salt dome in Lafourche Parish for a crude oil storage depot. For many years the Sorrento dome in Ascension Parish and other domes have been similarly utilized. The Louisiana legislature enacted a law assigning the Department of Conservation the responsibility and authority to control salt dome storage.

The Federal Government filed an expropriation suit in Baton Rouge to get immediate possession of Bayou Choctaw salt dome for strategic storage of crude oil. A similar suit had previously been filed to expropriate West Hackberry dome. Oil storage was initiated in this dome in 1977.

In September, the DOE purchased the Weeks Island underground salt mine from Morton Salt Co. for $30 million. They began work to prepare the mine as a storage cavity. Storage of oil is scheduled to begin in July 1979. Morton will open another mine in the same dome at a deeper level.

Table 5.—Louisiana: Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt		Brine		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1973 --	285	9,976	5,411	30,065	7,456	26,170	13,152	66,211
1974 --	296	11,386	6,024	38,641	7,223	26,932	13,543	76,960
1975 --	275	15,112	5,320	36,542	6,572	25,462	12,166	77,116
1976 --	297	19,014	6,514	46,465	6,680	26,473	13,491	91,952
1977 --	295	18,975	6,133	50,512	6,773	27,390	13,201	96,878

[1] Data may not add to totals shown because of independent rounding.

Sand and Gravel.—Production was 22 million tons valued at $50.8 million. Both production and value were approximately the same as in 1976. A total of 100 companies with 139 operations reported production from 30 of the State's 64 parishes. Leading parishes in descending rank of production were East Baton Rouge, Washington, West Feliciana, St. Helena, and St. Tammany. These five parishes produced 46% of the State's output of sand and gravel.

Of the total sold and used, construction sand and gravel made up nearly 99% with a value of $48.6 million. Industrial sand and gravel sales were only 1% of the total quantity and were valued at $2.2 million. Principal uses of the construction sand and gravel were for concrete aggregate and concrete products, fill, roadbase and coverings, and asphaltic concrete aggregates and other bituminous mixtures.

Industrial sand was used mainly as glass sand, blast sand, and engine sand.

The sand and gravel industry continued to have problems with environmentalist objections and land use conflicts. The Federal Surface Mining Control Act of 1977 was signed into law on August 3. Although this act pertains only to coal mining, there is a provision which requires studies of noncoal minerals which may come under Federal legislation. Sand and gravel is one of the noncoal minerals, and a report with specific legislative recommendations is due Congress on August 3, 1978.

Table 6.—Louisiana: Sand and gravel sold or used in 1977, by use

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	10,227	$19,125	$1.87
Gravel	11,476	29,510	2.57
Total or average	21,703	48,635	2.24
Industrial sand and gravel	284	2,155	7.58
Grand total or average	21,987	50,790	2.31

Table 7.—Louisiana: Construction sand and gravel sold or used in 1977, by major use category

Use	Quantity	Value	Value per ton
Concrete aggregate	11,277	$29,376	$2.60
Concrete products	1,575	3,485	2.21
Asphaltic concrete	2,737	6,876	2.51
Roadbase and coverings	2,874	5,298	1.84
Fill	3,186	3,481	1.09
Other	54	119	2.20
Total or average	21,703	48,635	2.24

Stone.—Production was principally crushed and broken clam and oyster shells. Eight companies produced crushed stone at 15 locations for roadstone, roadbase, bituminous aggregate, cement manufacture, lime manufacture, and other uses. Output was 9.7 million tons valued at $26.9 million. Leading producers were Southern Industries, Inc., Pontchartrain Dredging Corp., and Parker Bros. & Co., Inc.

Among the States, Louisiana was the leading producer of shell.

Sulfur.—Frasch sulfur, Louisiana's top-valued nonmetallic mineral, was recovered from the caprock of four salt domes near the gulf coast in 1977. Louisiana's production of 2.5 million long tons was approximately 41% of the total U.S. production. Stocks at the end of the year totaled 1.3 million long tons, down 20,000 long tons from the beginning stocks.

Recovered elemental sulfur was produced as a coproduct at five refineries in five different parishes: Calcasieu, East Baton Rouge, Plaquemines, St. Charles, and St. John the Baptist. Production totaled 157,000 long tons valued at $7.3 million. Texas and Louisiana accounted for about 66% of the total domestic sulfur production of 10.6 million long tons.

The average shipment value per long ton of Frasch and recovered elemental sulfur f.o.b. mine/plant was down about 3% in 1977 from the previous year. The posted price ex-terminal Tampa, Fla., was $65 per long ton at yearend.

Freeport Minerals Co., the major producer in Louisiana, produced nearly 2.3 million tons in 1977, about the same as in 1976. Output was programed to balance sales. The company has spare productive capacity at the Garden Island Bay and Grand Isle mines as well as potential output from sulfur deposits at Caillou Island and Caminada. Various new thermal efficiency and other techniques at the 44-year-old Grand Ecaille mine, which produced about 310,000 tons in 1977, gave hope that this mine might be maintained in operation until recovery in the relatively short-term future of its remaining reserves.

Table 8.—Louisiana: Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1973	3,311	3,329	W
1974	3,308	3,426	W
1975	3,070	2,672	W
1976	2,487	2,445	W
1977	2,422	2,455	W

W Withheld to avoid disclosing company proprietary data.

Vermiculite.—This mineral was not mined in Louisiana; however, exfoliated vermiculite was produced by Zonolite Division of W. R. Grace & Co. in New Orleans. The principal use of exfoliated vermiculite was as an admixture in concrete aggregate and as block insulation. Other uses included horticulture, loose fill insulation, soil conditioner, and plastic aggregate.

METALS

The primary metals industries of Louisiana (aluminum, nickel, and uranium) are wholly dependent on imported ores and is a very important part of the State's mineral industry.

Aluminum.—Bauxite from Jamaica was processed into alumina at the Gramercy and Baton Rouge plants of Kaiser Aluminum & Chemical Corp. Ore from Surinam was processed at the Ormet Corp.'s Burnside plant. Metallic aluminum was produced at the Kaiser reduction plant at Chalmette and at the Consolidated Aluminum Corp. plant at Lake Charles.

Nickel.—AMAX Nickel Refining Co., Inc., a division of AMAX, Inc., continued to process imported intermediate (matte) materials at the Port Nickel facility 15 miles downriver from New Orleans. Plant expansions and revisions have been designed for a process that is essentially hydrometallurgical, thereby eliminating most problems affecting the environment. Nickel-copper-cobalt matte from Botswana and the Republic of South Africa, along with nickel cobalt matte from New Caledonia, are sources of the plant's feed. Rated capacity of the plant is 40,000 tons of nickel, 23,500 tons of copper, 500 tons of cobalt, and 100,000 tons of ammonium sulfate as a byproduct. According to the company's annual report, the refinery produced approximately 25,000 tons of nickel in 1977. Shipments of finished products were made throughout the year to domestic and international destinations. Although the price of nickel was increased from $2.20 per pound to $2.41 per pound as of October 1, 1976, it never really took effect. The price increase was rescinded to its former level of $2.20 per pound on July 25, 1977.

Uranium.—Freeport Uranium Recovery Co., a subsidiary of Freeport Minerals Co., continued constructing facilities for recovering uranium oxide from phosphoric acid at the Freeport Chemical Co. phosphoric acid complex at Uncle Sam. Trace amounts of uranium oxide occurring in the Florida phosphate rock used as feed will be recovered. The new facility was designed to have the capacity to recover 690,000 pounds of uranium oxide annually. The phosphoric acid process stream of the Uncle Sam plant will be piped into the new plant where the previously unrecovered uranium values will be stripped from the process stream. The cleaned phosphoric acid will then be returned to the Uncle Sam facility. The recovered uranium values will be processed into yellowcake and then transported to commercial convertors for processing into fuel for electric powerplants. The company hopes to improve processing techniques and possibly extract other valuable constituents such as fluorine and rare-earth minerals, in addition to uranium, from the phosphoric acid stream.

Construction began in late 1976. Startup operations are anticipated to commence in late 1978 and to reach design capacity of uranium oxide in 1979.

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[1] State Liaison Officer, Bureau of Mines, Baton Rouge, La.

[2] Acting State Geologist, Louisiana Geological Survey, Baton Rouge, La.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	Parish
Aluminum:			
Consolidated Aluminum Corp	Box LL Lake Charles, LA 70601	Plant	Calcasieu.
Kaiser Aluminum & Chemical Corp	Box 1600 Chalmette, LA 70043	do	St. Bernard.
Cement:			
Lone Star Industries, Inc.[1]	One Greenwich Plaza Greenwich, CT 06830	do	Orleans.
OKC Corp.[1] [2]	Box 10426 Dallas, TX 75207	do	Do.
Clays:			
Big Rivers Industries, Inc	Box 66377 Baton Rouge, LA 70806	Mine and plant	Pointe Coupee.
Kentwood Brick & Tile Manufacturing Co., Inc.	Drawer F Kentwood, LA 70444	do	St. Helena.
Gypsum:			
Winn Rock, Inc.[2]	Box 790 Winnfield, LA 71483	Mine	Winn.
Lime:			
Allied Chemical Corp.[3]	Box 1219R Morristown, NJ 07960	Plant	East Baton Rouge.
Olin Corp	Box 2896 Lake Charles, LA 70601	do	Calcasieu.
Salt:			
Cargill, Inc	Cargill Building Minneapolis, MN 55402	Underground mine	St. Mary.
Diamond Crystal Salt Co	916 Riverside Ave. St. Clair, MI 48079	do	Iberia.
The Dow Chemical Co	Midland, MI 48640	Brine wells	Iberville.
International Salt Co	Clarks Summit, PA 18411	Underground mine	Iberia.
Morton Salt Co	110 N. Wacker Dr. Chicago, IL 60606	do	Do.
PPG Industries, Inc	Box 1000 Lake Charles, LA 70604	do	Calcasieu.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	Parish
Sand and gravel:			
Gifford-Hill & Co., Inc	Box 47127 Dallas, TX 75247	Plant and dredge	Jefferson Davis, Tangipahoa, Webster.
Louisiana Sand and Gravel Co	Box 963 Baton Rouge, LA 70800	do	East Baton Rouge.
Standard Gravel Co., Inc	Route 4, Box 17 Franklinton, LA 70438	do	Washington.
Stone:			
Lake Charles Dredging & Towing Co	Lafayette, LA 70501	Dredge	St. Mary.
Louisiana Materials Co.[1]	Box 8214 New Orleans, LA 70122	do	St. Tammany.
Southern Industries, Inc	Drawer 946 Mobile, AL 36601	do	Orleans.
Sulfur, native:			
Freeport Minerals Co	161 East 42d St. New York, NY 10017	Frasch process	Jefferson and Terrebonne.
Texasgulf, Inc	200 Park Ave. New York, NY 10017	do	Lafourche.
Sulfur, recovered:			
Cities Service Oil Co	Box 300 Tulsa, OK 74102	Refinery	Calcasieu.
Exxon Co., U.S.A	Box 551 Baton Rouge, LA 70821	Plant	East Baton Rouge.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	do	Orleans.

[1] Also clays.
[2] Also stone.
[3] Also salt.

The Mineral Industry of Maine

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Department of Conservation, Maine Geological Survey, for collecting information on all minerals except fuels.

By William R. Barton[1] and Robert G. Doyle[2]

Mineral production in Maine during 1977 was valued at $43.2 million, a 7% increase over that of 1976, according to reports filed by mineral producers with the Federal Bureau of Mines. The increase was primarily due to the general effects of inflation in the national economy and increased production of sand and gravel. Production of copper and zinc ceased during the year. The mineral products, in decreasing order of value, were sand and gravel, cement, zinc, stone, copper, gem stones, clays, lead, peat, and feldspar.

While mining directly contributes only a small fraction of 1% of the Maine gross State product, construction (which uses mineral raw materials) contributes 7%, and mineral-product-dependent manufacturing categories contribute about 10%.

Of the 24,000 people employed in the manufacturing of metal and nonmetallic products, 1,600 were directly involved in mineral extraction and processing. Total employed civilian labor force was 470,000. In some areas, the mineral industry pays a significant share of the property taxes. For example, the Martin Marietta Cement Corp. plant pays 40% of the property taxes in Thomaston, and Kerramerican, Inc., paid 9% of Blue Hill's total tax bill prior to closing of its operation in 1977.

Table 1.—Mineral production in Maine[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Clays thousand short tons	134	$216	98	$160
Copper (recoverable content of ores, etc.) short tons	1,766	2,459	1,337	1,787
Gem stones	NA	1,105	NA	W
Lead short tons	216	100	178	109
Peat thousand short tons	5	173	5	80
Sand and gravel do	[2]10,312	[2]13,950	10,487	19,023
Stone do	1,443	4,609	1,312	4,110
Zinc (recoverable content of ores, etc.) short tons	7,810	5,779	7,269	5,001
Combined value of cement, feldspar, sand and gravel (industrial, 1976), silver (1976), and items indicated by symbol W	XX	11,973	XX	12,955
Total	XX	40,364	XX	43,225
Total 1967 constant dollars	XX	20,719	XX	[p]21,336

[p] Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes industrial sand and gravel; value included in "Combined value" figure.

Exploration for minerals continued at an unabated pace during 1977. Activities extended throughout the State with major interest in base metals, uranium, and possible nickel-cobalt.

The Maine Geological Survey published three geological quadrangle maps: GM-3, "Geologic Map and Cross Sections of the Eastport Quadrangle," GM-4, "Geologic Map of the Kezar Falls Quadrangle," and GM-5, "Geologic Map of the Skowhegan Quadrangle." The Survey also published several index maps— "Bedrock Geologic Maps of Maine," "Surficial Geologic Maps of Maine," "Ground Water Resource Maps, County Series," "Maine Coastal Zone, Water Supply and Demand," and "Coastal Marine Geology Maps."

The U.S. Geological Survey, in cooperation with the Maine Public Utilities Commission, published Hydrologic Investigation Atlas HA-564, "Ground-Water Favorability and Surficial Geology of the Windham-Freeport Area, Maine."

Legislation and Government Programs.—The State legislature passed and Governor Longley signed into law, "An Act to Improve the Management of the Department of Conservation." The new public law included a new Maine Revised Statute Annotated Chapter 201-A on Mining and Minerals. The chapter established and described the functions of the Maine Geological Survey and the State Geologist, codified mining on State lands, and gave jurisdiction to the Maine Geological Survey.

The Land Use Regulation Commission (LURC) adopted a plan to regulate the use of Maine's unorganized territories. The plan regulates over half the land mass in the State where no formal local government exists. The new land-use standards require permits for extraction of minerals to assure appropriate use of resources consistent with the comprehensive land-use plan. The standards are available from LURC as chapter 10 of their rules and regulations (adopted January 12, 1977). An overall summary of Maine planning and land-use laws was available from the State Planning Office in an information pamphlet entitled "Maine Planning and Land Use Laws."

Maine planning uder the Federal Coastal Zone Management Act proceeded during the year with preparation of a draft Environmental Impact Statement (EIS). The draft EIS did not adequately cover mineral resources that were not considered of national interest.

Table 2.—Value of mineral production in Maine, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Androscoggin	W	W	Sand and gravel, clays.
Aroostook	W	W	Sand and gravel, stone.
Cumberland	W	W	Sand and gravel, stone, clays.
Franklin	$768	$536	Sand and gravel.
Hancock	9,195	W	Zinc, copper, sand and gravel, lead, stone, clays.
Kennebec	W	W	Sand and gravel, stone.
Knox	W	W	Cement, stone, sand and gravel, clays.
Lincoln	W	430	Sand and gravel.
Oxford	569	W	Sand and gravel, feldspar.
Penobscot	W	3,034	Sand and gravel.
Piscataquis	148	648	Do.
Sagadahoc	W	W	Do.
Somerset	846	599	Do.
Waldo	537	W	Sand and gravel, peat.
Washington	W	W	Sand and gravel, peat, stone.
York	1,471	1,762	Sand and gravel.
Undistributed[1]	26,828	36,215	
Total[2]	40,364	43,225	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes gem stones and items indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Maine business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	472.0	470.0	-0.4
Unemployment do	42.0	39.0	-7.1
Employment (nonagricultural):			
Mining do	(1)	(1)	--
Manufacturing do	102.5	105.9	+3.3
Contract construction do	22.1	20.5	-7.2
Transportation and public utilities do	17.9	18.0	+.6
Wholesale and retail trade do	79.2	83.7	+5.7
Finance, insurance, real estate do	14.6	15.1	+3.4
Services do	[2]63.8	[2]67.3	+5.5
Government do	75.2	77.3	+2.8
Total nonagricultural employment do	375.3	387.8	+3.3
Personal income:			
Total millions	$5,750	$6,221	+8.2
Per capita	$5,367	$5,734	+6.8
Construction activity:			
Number of private and public residential units authorized	4,206	4,753	+13.0
Value of nonresidential construction millions	$46.1	$59.5	+29.1
Value of State road contract awards do	$23.3	$30.5	+30.9
Shipments of portland and masonry cement to and within the State thousand short tons	319	269	-15.7
Mineral production value:			
Total crude mineral value millions	$40.4	$43.2	+7.1
Value per capita, resident population	$38	$40	+5.3
Value per square mile	$1,215	$1,301	+7.1

[p] Preliminary.
[1] Included with "Services."
[2] Includes mining.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

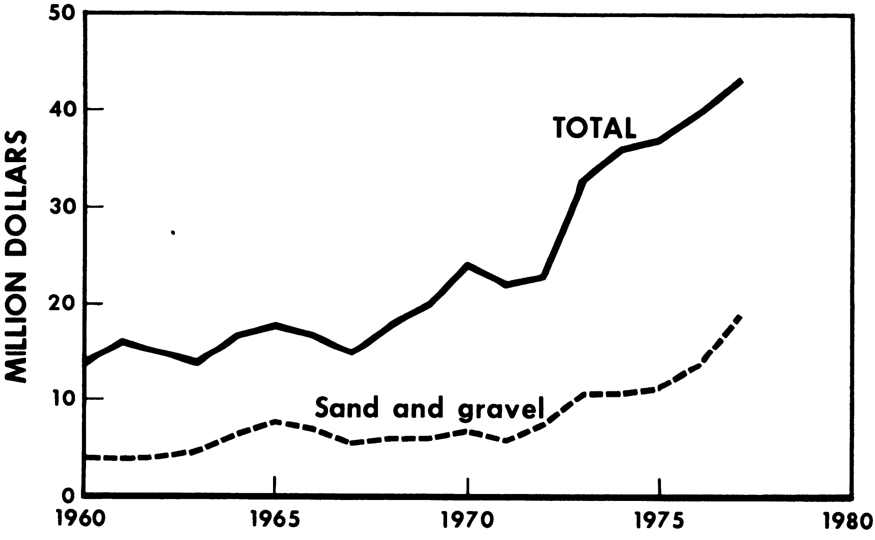

Figure 1.—Value of sand and gravel and total value of mineral production in Maine.

Table 4.—Worktime and injury experience in the Maine mineral industry in 1977[1]

	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate	Nondisabling injuries	Nondisabling injury frequency rate
Copper:								
Underground	70	111,592	--	--	20	179.22	--	--
Mills	26	43,487	--	--	2	45.99	--	--
Office	15	25,637	--	--	--	--	--	--
Total	111	180,716	--	--	22	121.74	--	--
Sand and gravel:								
Surface	796	968,950	--	--	13	13.41	2	2.06
Office	63	89,578	--	--	--	--	--	--
Total	859	1,058,528	--	--	13	12.28	2	1.89
Stone:								
Underground	4	8,280	--	--	--	--	--	--
Surface	107	171,213	--	--	9	52.57	12	70.09
Mills	152	281,314	--	--	--	--	2	7.11
Office	43	80,223	--	--	--	--	--	--
Total	306	541,030	--	--	9	16.63	14	25.88
Clays:								
Surface	12	15,336	--	--	--	--	--	--
Mills	26	46,540	--	--	--	--	--	--
Office	7	10,558	--	--	--	--	--	--
Total	45	72,434	--	--	--	--	--	--
Feldspar:								
Surface	6	2,265	--	--	--	--	--	--
Mills	5	3,397	--	--	1	194.38	--	--
Office	1	1,160	--	--	--	--	--	--
Total	12	6,822	--	--	1	146.58	--	--
Peat:								
Surface	21	21,083	--	--	1	47.43	1	47.43
Mills	4	500	--	--	--	--	--	--
Office	1	513	--	--	--	--	--	--
Total	26	22,096	--	--	1	45.26	1	45.26
State total:								
Underground	74	119,872	--	--	20	166.84	--	--
Surface	947	1,181,607	--	--	23	19.47	15	12.69
Mills	213	375,238	--	--	3	7.99	2	5.33
Office	130	207,669	--	--	--	--	--	--
Grand total	1,364	1,884,386	--	--	46	24.41	17	9.02

[1] Data supplied by Mine Safety and Health Administration, U.S. Department of Labor.

A study was underway to place the east and west branches of the Penobscot River in the Wild and Scenic River Program of the U.S. Department of the Interior. Mineral exploration data were lacking in the area; therefore, no assesment could be given the mineral potential of the area under consideration.

The planned Dickey-Lincoln School Hydroelectric Powerplant (and attendant transmission corridors) of the U.S. Army Corps of Engineers constituted another possible future action whose impact on mineral resources and future mining activity could not be fully assessed due to incomplete data on minerals.

In recognition of Maine's serious water quality problems, five regions of the State were designated to receive money under Section 208 of the 1972 Federal Water Pollution Control Act as amended. Grants of $2.12 million were made to assist planning to restore and protect water quality. The total effect on mining from planned new regulations was not projected.

Mineral Exploration and Developments.—Superior Oil Co. and Louisiana Land and Exploration Co. reported a major copper-zinc discovery in Aroostook County northwest of Ashland.

A garnet deposit near Rangeley was being developed for mining by Industrial Garnet Extractives Co. Lime Products Corp. developed additional acreage for limestone mining at Union. Island Resources, Inc., reopened the Crotch Island granite quarry.

Leases on the copper-nickel prospect in Knox County were being maintained by Hanna Mining Co. and Basic Inc. The Portland-Monson Slate Co. completed its production shaft and started mining black slate.

Sobin Chemical Co. (a subsidiary of IMC Chemical Group, Inc.) began a $15 million expansion to double plant size. The firm has been producing chlorine and caustic soda from imported salt, and when expansion is completed in 1978 will add sodium chlorate and hydrochloric acid to the product line.

Twelve coastal sites were identified by the Maine Geological Survey as suitable for possible future underground storage of petroleum products; each site would require detailed study and core drilling. Several of the sites are in mineralogically promising areas and drilling might yield auxillary information concerning areal geology and mineral potential. Rock excavated at any site brought to development would presumably be marketable as crushed stone.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Martin Marietta Cement Corp. operated the only cement plant in New England at Thomaston. Value of the product increased slightly compared with that of 1976. Consumption of cement in Maine, as measured by destination of shipments from domestic producers, was 259,000 tons of portland cement and 10,000 tons of prepared masonry cement.

Major markets for the cement produced at Thomaston were in Maine, New Hampshire, and eastern Massachusetts. About 61% of the product was for ready-mix customers; 22%, for use in manufactured concrete products; 10%, for building material dealers; and 7%, for masonry cement. More than 99% of the portland cement produced was the gray, general-use, and moderate-heat type.

Clays.—Production of clay in 1977 was 98,000 tons, valued at $160,000, an increase in quantity and a decrease in value. Clays were produced in Androscoggin, Cumberland, Hancock, and Knox Counties. A major percentage was used in cement manufacture and the remainder was consumed in the production of brick.

Feldspar.—Oxford Feldspar and Mineral Corp. continued to operate the old Bell Minerals grinding mill at West Paris. Feldspar was purchased for processing from Mt. Zion Mining Co. at Red Hill, Plumbago Mining Co. at Newry Hill, and other independent miners in Oxford County. The ground feldspar product was shipped to Massachusetts and New York for use in the manufacture of electrical insulators and to intrastate firms for use as a soil conditioner or in pottery manufacture.

Garnet.—A garnet diorite at Wing Hill north of Rangeley was being developed for mining by Industrial Garnet Extractives Co. It is planned to process the mineral into a sand-size product for use in water and waste filtration, sand blasting, and high-density concrete.

A threatened closure of the Farmington branch of the Maine Central Railroad might adversely affect the proposed mineral operation.

Gem Stones.—The State, particularly areas where pegmatite minerals have been mined, continued to be an attraction for collectors and rockhounds. Plumbago Mining Corp. continued to market tourmaline, most of which was sold from stock mined during 1972 and 1973. The Maine Retail Jewelers Association presented the State and people of Maine with a $25,000 necklace of Maine tourmaline and gold that featured a 24.58-carat Newry Hill tourmaline as a center drop stone. The necklace will be displayed in the State Museum and will be available to Maine's first ladies to wear to official functions. Several reports on Maine gems or gem localities were published during the year.[3]

Graphite, Synthetic.—Filer Materials, Inc., of York County produced synthetic graphite during the year. All the production was used in refractories and cloth.

Peat.—Peat was produced by Pioneer Peat Moss Co., International Peat Moss Co. Inc., and Deer Hill Farms. The Down East Peat Co. was developing Denbo Heath near Deblois in Washington County for production of sphagnum peat starting in 1978. The equipment being assembled by the firm will be among the world's largest peat harvesting machinery. Folsom Marine Service Corp. of Concord, N.H., was developing another peat bog for production near Saco in York County. Acadia Peat Corp. did not produce in 1977 but sold from stock. Coastal Resource Center Inc., Bar Harbor, continued its research project on strategies to develop Maine peat resources in an environmentally acceptable manner.

The Maine Geological Survey and the U.S. Geological Survey were continuing investigation of peat deposits in Maine. Studies have been completed on Aroostook, Washington, and Hancock Counties. Resources in the three-county area were estimated to be about 34 million tons of air-dried peat. A cooperative project to complete the study for the entire State was expected to last for 5 years. The Maine Office of Energy Resources and the Bureau of Geology proposed a cooperative project to the U.S. Department of Energy to study the use of peat as an energy source. This project will complement the peat resource study.

Perlite.—Chemrock Corp. expanded crude perlite from New Mexico at its plant near Thomaston. Marine Colloids Inc. used most of the expanded perlite as a filter aid while producing carragheen from seaweed.

Sand and Gravel.—Production of sand and gravel was 10.5 million tons valued at $19 million, an increase in quantity and value over that of 1976. A total of 105 companies and government-and-contractor operations were active during the year producing from 148 pits. Leading counties in descending order of output were Penobscot, Cumberland, Aroostook, and Kennebec. About 37% was used on government projects and the remaining for commercial projects. Use distribution was 15% for concrete aggregate, 14% for bituminous mixtures, 34% for roadbase stone, 22% for fill, 7% for concrete products, and 8% for the remainder.

Table 5.—Maine: Sand and gravel sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Androscoggin	17	627	1,138	16	737	1,586
Aroostook	8	1,153	1,372	9	1,035	1,726
Cumberland	18	1,350	2,039	18	1,391	2,571
Franklin	7	468	768	6	223	536
Hancock	10	503	743	10	527	1,073
Kennebec	11	1,013	876	14	1,022	1,755
Knox	5	448	724	4	545	1,222
Lincoln	2	W	W	--	W	W
Oxford	9	407	543	9	223	384
Penobscot	17	1,529	2,115	19	1,812	3,034
Piscataquis	5	211	148	5	416	648
Sagadahoc	2	W	W	--	W	W
Somerset	6	589	846	6	362	599
Waldo	10	474	536	9	542	943
Washington	8	371	300	8	324	463
York	13	858	1,457	10	833	1,762
Undistributed	--	311	345	5	495	720
Total[1]	148	10,312	13,950	148	10,487	19,023

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Maine: Construction sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Sand	5,715	5,580	3,980	7,218
Gravel	4,597	8,369	6,507	11,805
Total	10,312	[1]13,950	10,487	19,023

[1] Data do not add to total shown because of independent rounding.

Table 7.—Maine: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	2,046	2,689	1,579	3,624
Concrete products (cement blocks, bricks, pipe, etc.)	786	2,694	779	2,085
Asphaltic concrete aggregates and other bituminous mixtures	1,681	3,237	1,509	3,026
Roadbase and coverings	2,956	2,134	3,553	5,967
Fill	1,307	1,565	2,289	3,259
Railroad ballast	--	--	15	24
Other uses	1,534	1,630	763	1,038
Total[1]	10,312	13,950	10,487	19,023

[1] Data may not add to totals shown because of independent rounding.

Stone.—Nine companies crushed stone at 12 quarries for cement, bituminous aggregate, concrete aggregate, and other uses. Output decreased 9% to 1.3 million tons valued at $4.1 million. Leading producers were Martin Marietta Cement Corp., Blue Rock Industries, and Lane Construction Corp.

The Crotch Island granite quarry near Stonington was reopened by Island Resources Inc. of Camden. The granite will be quarried on a special-order basis. The last large project to utilize the Deer Isle-type granite was the John F. Kennedy Memorial in Arlington, Va. A book was published that gave a detailed history of the Maine granite industry.[4]

Lime Products Corp. began full operation of a new $500,00 limestone quarry and crushing plant near Warren. The 250-ton-per-hour facility is additional capacity to the existing company facility at Union where quarrying operations were being expanded onto additional acreage.

The Portland-Monson Slate Co. completed its production shaft and was mining high-quality black slate. The slate was primarily for use in tile and electrical fixtures.

The Federal Bureau of Mines was evaluating waste slate from Monson at its Tuscaloosa (Ala.) Metallurgy Research Center to attempt to determine what byproducts might be made from it.

Trombley Redi-Mix Co. near Chapman in Aroostook County planned development of a quarry for crushed stone for use in its concrete operations. The Board of Environmental Protection issued an operating permit that included strict regulations to eliminate all possible adverse environmental and social effects.

METALS

After 5 years of mining, Kerramerican, Inc., suspended its mining operation at Blue Hill in October. Kerramerican was a joint venture of Kerr Addison Mines, Ltd., and Black Hawk Mining, Ltd. Production atthe property during the year to the time of suspension was 143,200 tons of ore of 1.1% copper and 5.7% zinc. Concentrates produced contained 1,337 tons of copper, 178 tons of lead, and 7,269 tons of zinc. Operating equipment was removed from the mine, and mine openings were sealed with concrete bulkheads. The mill will be kept on a care-and-maintenance basis. To prevent the sulfide tailings from becoming a pollution threat, the upraised portion was covered with glacial till and vegetated and the balance submerged under water.

At closing there remained a substantial inventory of zinc concentrates that was being shipped to St. Joe Minerals Corp. at Monaca, Pa., for smelting. The copper concentrates were shipped to the Noranda Mines Ltd., Gaspé smelter at Murdockville, Quebec. All shipments were to be completed by mid-1987. Another ore body exists near the workings at Blue Hill but could not be considered minable in the circumstances of the current metal market. The company had about 100 employees. During the 5 years of operation, the mine and mill produced concentrates containing more than 65,000 tons of zinc and 7,500 tons of copper.

Superior Oil Co. and Louisiana Land and Exploration Co., using the contractual services of J. S. Cummings Co. of Bangor, made a major copper-zinc discovery in Township 12, Range 8, Aroostook County, northwest of Ashland. From the data gathered, it was estimated that a minimum of 40 million tons of sulfide mineralization is present in the deposit. Assays indicated two main ore types, one with an average of 3.38% zinc, 0.11% copper, and 0.861 troy ounce of silver and 0.0074 troy ounce of gold per ton. The two companies have joint control of about 252,000 acres of land leased from Great Northern Nekoosa Paper Co., and additional evaluation of other propsects on the acreage was also planned. The two firms also were reported to be involved in additional drilling in Parmacheene Township and south of Fish River Lake.

Leases on a nickel-copper prospect in Knox County were being maintained by Hanna Mining Co. and Basic Inc. to preserve their position should future demand for nickel improve.

The nickel-copper potential of the Katahdin basic rock complex was also reported to be a subject of interest. Associated with the complex are long known, huge, massive pyrrhotite deposits.

Standard Metals Corp. continued to postpone drilling of air electromagnetic anomalies in the Red Ridge and other areas on properties leased from the Brown Co.

Aquitaine Co. of Canade Ltd. reported that drilling had failed to locate copper-zinc deposits of commercial quality in 1977 in the Appalachian volcanic rocks in Bowman and Oxbow Townships. Geophysical work and drilling were to continue.

Phelps-Dodge Exploration East, Inc., opened an office in Bangor and was looking at base metal prospects in both the northern and coastal Maine belts, as well as for radioactive minerals elsewhere in New England.

Newmont, Rio Tinto, Allied Chemical Co., Kerr-McGee, Bethlehem Steel, Noranda, General Crude Oil (International Paper Co.), and Houston Oil and Minerals are among other firms reported to be actively interested in the State.

The American Hoist and Derrick Co. in Portland consumed zinc at about the same level as the previous year. Numerous parts produced in their foundry were hot-dip galvanized according to customer specifications.

Schiavone of Maine, a division of Michael Schiavone and Sons, Inc., operated the only scrap metal shredder in Maine at Leeds. The firm produced about 2,000 tons of shredded ferrous scrap per year for foreign markets. Nonferrous scrap was sent to the Schiavone recycling center in Connecticut.

Philips Elmet Corp., Lewiston, continued importing tungsten and molybdenum and producing tungsten and molybdenum wire and parts using powder metallurgy techniques. About half of the finished products were used within the North American Philips Corp. electronics industry.

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[1] State Liaison Officer, Bureau of Mines, Newmarket, N.H.

[2] State geologist, Department of Conservation, Maine Geological Survey, Augusta, Maine.

[3] Acord, J. P. Tourmaline. Lapidary J., pt. 1, v. 31, No. 1, April 1977, pp. 216-229; pt. 2, v. 31, No. 2, May 1977, pp. 512-525.

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Thompson, W. B. Maine Tourmaline Localities and Their Relevance to the Critical Areas Program. Maine State Planning Office Planning Rept. 31, May 5, 1977.

Wilson, W. E. Famous Mineral Localities - The Pulsifer Quarry. Mineral. Rec., v. 8, No. 2, March-April 1977, pp. 72-77.

[4] Grindle, R. L. Tombstones and Paving Blocks. Courier-Gazzette, Inc., Rockland, Maine, 1977, 277 pp.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Martin Marietta Cement Corp., Eastern Div.[1]	11300 Rockville Pike Rockville, MD 20852	Quarry and plant	Knox.
Clays:			
Dennis Brick Co., Inc	Mt. B Washington St. Auburn, ME 04210	Pit and mill	Androscoggin.
Lachance Brick Co., a division of Morin Brick Co.	Mosher Rd. Gorham, ME 04038	do	Cumberland.
Morin Brick Co	Danville, ME 04223	do	Androscoggin.
Rowantrees, Inc	Union St. Blue Hill, ME 04614	Pit	Hancock.
Royal River Brick Co., Inc.	Box 191 Gray, ME 04039	Pit and mill	Cumberland.
Feldspar:			
Oxford Feldspar Corp	Box 115A West Paris, ME 04289	Mill	Oxford.
Gem stones:			
Plumbago Mining Corp	Rumford, ME 04276	Mine	Do.
Peat:			
Deer Hill Farms, Inc	Weeks Mills, ME 04361	Bog	Franklin.
International Peat Moss Co. Inc.	430 Trapelo Rd. Belmont, ME 02178	Bog and plant	Washington.
Pioneer Peat Moss Co	Centerville, ME 04649	do	Do.
Perlite (expanded):			
Chemrock Corp	End of Osage St. Nashville, TN 37208	Plant	Knox.
Sand and gravel:			
Blue Rock Industries	58 Main St. Westbrook, ME 04092	5 pits and mills	Androscoggin, Cumberland, Franklin, York.
Cianbro Corp	Box D Pittsfield, ME 04967	7 pits and mills	Franklin, Hancock, Oxford, Penobscot, Somerset.
H. C. Crooker & Sons, Inc	R.D. 3 Brunswick, ME 04011	Pit	Cumberland and Lincoln.
George C. Hall Excavating	Box 506 Rockland, ME 04841	2 pits and plant	Knox.
G. E. Goding & Son, Inc	Route 1, Box 78A Lincoln, ME 04457	2 pits and plant	Penobscot.
Lane Construction Corp	965 East Main St. Bangor, ME 04401	4 pits and mills	Aroostook, Penobscot, Waldo, Washington.
Portland Sand and Gravel Co., Inc.	Gray Rd. Cumberland, ME 04021	Pit and mill	Cumberland.
H. E. Sargent, Inc	101 Bennoch Rd. Stillwater, ME 04489	7 pits and mills	Aroostook, Cumberland, Franklin, Penobscot, Somerset, Washington.
Warren Bros. Co., a division of Ashland Oil, Inc.	Fairfield, ME 04937	5 pits and mills	Cumberland, Penobscot, Somerset, York.
Stone:			
Granite, dimension:			
The John Swenson Granite Co., Inc.	North State St. Concord, NH 03301	3 quarries	Hancock and York.
Limestone, crushed:			
Blue Rock Industries[2]	58 Main St. Westbrook, ME 04092	do	Cumberland and Kennebec.
Lane Construction Corp	965 East Maine St. Bangor, ME 04401	Quarry	Aroostook.
Lime Products Corp	Box 357 Union, ME 04862	Quarry and mill	Knox.
Marl:			
Stanley Giles	17 Mechanic Rd. Presque Isle, ME 04769	do	Aroostock.
Miscellaneous stone:			
Cianbro Corp	Box D Pittsfield, ME 04967	7 pits and mills	Franklin, Hancock, Oxford, Penobscot, Somerset.
Cook Concrete Co	960 Ocean Ave. Portland, ME 04103	Quarry	Cumberland.
Hughes Bros., Inc	Box 565 Bangor, ME 04401	2 pits and mill	Penobscot and Waldo.
Thomas DiCenzo, Inc	75 Barker St. Calais, ME 04619	Quarry	Washington.
Slate:			
Portland-Monson Slate Co	Monson, ME 04464	Underground mine and plant.	Piscataquis.
Zinc:			
Kerramerican, Inc.[3]	Box N Blue Hill, ME 04614	Mine and plant	Hancock.

[1] Portland and masonry. [2] Also crushed sandstone. [3] Also copper and lead.

The Mineral Industry of Maryland

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Maryland Geological Survey for collecting information on all minerals in the State.

By Joseph A. Sutton[1] and Marilyn N. Dimmitt[2]

Total value of Maryland's mineral production in 1977 was $187 million, about 1% above that of 1976. The increase was due primarily to higher prices rather than to greater mineral production.

The value of mineral production in the State was divided as follows: Coal, 29%; natural gas, less than 1%; stone, 27%; sand and gravel, 16%; clays, 1%; gem stones, lime, peat, cement, and ball clay accounted for the remainder.

Three serpentinite quarries that produce about 18% of the crushed stone used in the State were reported to contain small quantities of chrysotile asbestos. Maryland's Department of Health and Mental Hygiene, Montgomery County's Department of Environmental Protection, and the U.S. Environmental Protection Agency (EPA) initiated studies to determine if the general public was being exposed to asbestos contained in the serpentinite rock used on roads in Maryland. The results of these studies should be available to the general public sometime early in the calendar year 1978.

Employment.—Final 1976 statistics and preliminary data for 1977 on business activities of the State are given in table 3.

Legislation and Government Programs.—The State Legislature amended Sections 7-6A04(a) and 7-6A19(b) of the Natural Resources Article. These amendments clarified the utilization of funds in the

Table 1.—Mineral production in Maryland[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	702	$1,817	893	$2,344
Coal (bituminous) do	2,830	61,974	3,036	53,676
Lime do	16	494	W	W
Natural gas million cubic feet	75	24	82	32
Peat thousand short tons	2	W	3	W
Sand and gravel do	12,942	31,914	11,702	29,562
Stone do	15,709	47,669	16,766	50,680
Combined value of cement, clays (ball), gem stones, and items indicated by symbol W	XX	41,026	XX	50,405
Total	XX	184,918	XX	186,699
Total 1967 constant dollars	XX	94,918	XX	[p]92,155

[p] Preliminary. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes ball clay; value included with "Combined value" figure.

Table 2.—Value of mineral production in Maryland, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Allegany	W	$1,089	Stone.
Anne Arundel	$3,118	4,066	Sand and gravel.
Baltimore[2]	W	W	Stone, sand and gravel, clays.
Caroline	3	W	Sand and gravel.
Carroll	W	W	Cement, stone, clays.
Cecil	10,395	8,929	Stone, sand and gravel.
Charles	W	W	Sand and gravel.
Dorchester	W	W	Do.
Frederick	W	W	Cement, stone, clays, lime.
Garrett	W	W	Stone, sand and gravel, peat.
Harford	W	W	Sand and gravel, stone.
Howard	1,322	2,406	Stone.
Kent	W	19	Clays.
Montgomery	W	6,065	Stone.
Prince Georges	14,264	12,125	Sand and gravel, clays.
Queen Annes	--	W	Stone.
St. Marys	254	451	Sand and gravel.
Washington	W	W	Cement, stone, clays.
Wicomico	W	W	Sand and gravel.
Worcester	860	695	Do.
Undistributed[3]	154,702	150,859	
Total	184,918	[4]186,699	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Calvert, Somerset, and Talbot Counties are not listed because no production was reported.

[2] Includes Baltimore City.

[3] Includes some coal, natural gas, gem stones, and values indicated by symbol W.

[4] Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Maryland business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	1,892.0	1,947.0	+2.9
Unemployment do.	127.0	118.0	-7.1
Employment (nonagricultural):			
Mining do.	1.5	1.5	--
Manufacturing do.	232.5	235.7	+1.4
Contract construction do.	88.9	90.2	+1.5
Transportation and public utilities do.	78.0	78.7	+.9
Wholesale and retail trade do.	360.6	367.9	+2.0
Finance, insurance, real estate do.	80.2	82.0	+2.2
Services do.	287.0	294.9	+2.7
Government do.	372.6	377.7	+1.4
Total nonagricultural employment do.	1,501.3	1,528.6	+.2
Personal income:			
Total millions	$28,855	$31,337	+8.6
Per capita	$6,995	$7,572	+8.2
Construction activity:			
Number of private and public residential units authorized	26,994	30,431	+12.7
Value of nonresidential construction millions	$365.5	$439.0	+20.1
Value of State road contract awards do.	$92.2	$98.0	+6.3
Shipments of portland and masonry cement to and within the State thousand short tons	1,289	1,368	+6.1
Mineral production value:			
Total crude mineral value millions	$184.9	$186.7	+1.0
Value per capita, resident population	$45	$45	--
Value per square mile	$17,483	$17,651	+1.0

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Surface Mine Land Roclamation Fund and provided for certain waivers from the requirements of mining and reclamation plans. The legislature also added a new section to the Natural Resources Article (Section 7-517) that provides for the enjoining of violations and the assessment of civil penalties. This section also permits certain courts to enforce compliance with and enjoin the violation of certain orders of the Department of Natural Resources.

The Federal Bureau of Mines established one of its seven metallurgy research centers on the College Park campus in 1935, on land donated by the University of Maryland. In 1968, the university needed the land for expansion, so the Government returned the land and sold the buildings to the university. Since that time, the Bureau has been occupying the buildings under a 10-year no-cost lease that expires during the summer of 1978. In 1977, the Bureau was going through the process of making final plans for moving its College Park Metallurgy Research Center's activities to the Christian Brothers De LaSalle College, a facility purchased in December 1976, as a replacement for quarters on the University of Maryland campus.

The College Park Metallurgy Research Center's Particulate Mineralogy Unit, established in September 1976, continued to assist local, State, and Federal agencies in the identification and characterization of asbestiform minerals. A report titled "Selected Silicate Minerals and Their Asbestiform Varieties" was published for the purpose of providing precise definitions on asbestos particulates acceptable to mineral analysts, regulatory personnel, and medical scientists.[3]

The Maryland Coastal Resources Advisory Committee approved Maryland's Coastal Zone Management Program document for Federal review and public hearing on December 16, 1977. The Coastal Zone Management program is based on the premise that existing local, State, and Federal authorities are sufficient to regulate how Maryland's coastal zone is used. The State has developed a mechanism called project evaluation to provide a comprehensive review of proposed projects that could have adverse impacts on the Chesapeake Bay and its tributaries. Project evaluation will bring all the permitting agencies and other interested parties together to assess the potential effects of proposed developments at the beginning of the development approval process. The proposals will be evaluated, using a set of State coastal zone policies as a measuring instrument. These policies, enumerated in the Coastal Zone Management Program, represent the first unified statement of what Maryland hopes to accomplish in managing the bay.

The Maryland Geological Survey has been cooperating with the Federal Bureau of Mines in a limestone sampling and analysis project to evaluate potential uses for abundant limestone resources in the State. The State Survey was also continuing its inventory of mined lands. A mined-land inventory map of Baltimore County was published in 1975; the Anne Arundel County map was published in 1976; and the mined-land inventory of Prince Georges County is currently in progress.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Portland cement sold or used in the State in 1977 increased 4%. The value of sales increased 4% in 1977 compared with the 1976 figures. Masonry cement shipments also increased 12% and its value rose 23% in 1977 over that of 1976.

Maryland's leading portland cement producer continued to be the Union Bridge plant of the Lehigh Portland Cement Co. in Carroll County. Plants at Hagerstown and Lime Kiln were also in operation in 1977. The Flintkote Co. at Frederick and Marquette Cement Manufacturing Co. at Hagerstown were the only producers of masonry cement. Ready-mix companies consumed about 70% of the portland cement sold. Concrete product manufacturers, building material dealers, and highway contractors accounted for the remainder of the purchases.

The cement-manufacturing plants used large quantities of fuel oil, coal, and electric energy to convert the cement rock, limestone, and gypsum materials into cement.

Apparent consumption (shipments) of portland cement in Maryland in 1977 rose to 1.3 million tons, an increase of 6% over that of 1976, and masonry cement shipments to consumers jumped 13% in 1977 to 114,000 tons.

Clays.—The production of common clay and shale rose to 893,000 tons valued at $2.3 million. The 27% increase was based in large part by the expanded production of shale for lightweight aggregate for block manufacturing at the Lehigh Portland Cement Co.'s Woodsboro pit.

A small amount of ball clay was produced in Baltimore County by Cyprus Industrial Minerals Co.

Seven companies operated nine pits in six counties during 1977. The W. D. Bowman Maryland clay pit in Hartford County was idle.

Frederick County continued to provide the bulk of the clay mined in the State.

Gem Stones.—Production of semiprecious stones was limited to small quantities collected by dealers and amateur collectors.

Gypsum.—Calcined gypsum continued to be produced. United States Gypsum Co., the major producer, and National Gypsum Co. produced 7% more in 1977.

Lime.—Hydrated and quicklime was produced at a plant at Woodsboro in Frederick County. The quantity and value produced in 1977 declined 18% and 10%, respectively. S. W. Barrick & Sons, Inc., quarried its own limestone for this operation.

Peat.—Garrett County Processing & Packaging Corp., near Accident in Garrett County, produced 1,658 tons of reed sedge and 892 tons of humus for a total of 2,550 tons. A substantial reduction in the output of humus caused 1977 total production to decline 12%. However, because of the increase in sales, the total value jumped 20%.

Perlite.—National Gypsum Co. continued to produce expanded perlite for use in concrete and plaster aggregate. Output declined 6% for 1977.

Sand and Gravel.—A 1.2-million-ton decline in sand and gravel sold or used in 1977 forced the overall value of this commodity to drop $2.4 million, a decline of 7%. Fifty-six deposits supplied sand and gravel to 48 plants in 12 of Maryland's counties.

Prince Georges, Anne Arundel, and Cecil Counties were the major producing areas. Contee Sand & Gravel Co., Inc. (Prince Georges), York Building Products Co. Inc. (Cecil), and Harry T. Campbell and Sons Co. (Baltimore) were the leading producers.

Table 4.—Maryland: Construction sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	8,310	19,148	7,080	16,918
Gravel	4,631	12,766	4,621	12,644
Total[1]	12,942	31,914	11,702	29,562

[1] Data may not add to totals shown because of independent rounding.

Table 5.—Maryland: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	5,130	14,068	5,812	15,581
Concrete products (cement blocks, bricks, pipe, etc.)	1,975	5,299	1,635	4,162
Asphaltic concrete aggregates and other bituminous mixtures	736	1,846	2,206	5,122
Roadbase and coverings	3,554	7,674	955	1,699
Fill	873	1,503	585	1,217
Other uses	671	1,524	507	1,781
Total[1]	12,942	31,914	11,702	29,562

[1] Data may not add to totals shown because of independent rounding.

Stone.—State production of stone in 1977 ranked second in value behind coal at about $50.7 million.

Eleven counties, with Baltimore County as the leading producer, quarried 16.7 million tons of crushed stone and 30,000 tons of dimension stone. In the crushed stone group limestone accounted for 71% of tonnage, followed by traprock at 13%, and granite at 10%. Highway and other construction uses consumed 81% of the crushed stone; cement and lime manufacture, 13%; and miscellaneous other uses, 6%.

Sandstone was the major dimension stone; rough block, irregular- shaped, and rubble constituted 86% of the total of all dimension stone produced.

Serpentinite quarried in the State and sold in the form of crushed stone was reported to contain small quantities of chrysotile asbestos. Asbestos is a known carcinogen. The three serpentinite quarries that were reported to contain asbestiform minerals produced about 18% of the crushed stone used in the State.

The Environmental Health Administration of the Maryland Department of Health and Mental Hygiene, the Montgomery County Department of Environmental Protection, and EPA initiated studies in 1977 to determine if the public was being exposed to the asbestos contained in serpentinite rock used on roads in Maryland. The Federal Bureau of Mines analyzed several of the samples collected and reported the results to the agencies conducting the study.

Vermiculite (Exfoliated).—A nearly fourfold increase in the demand for loose fill insulation resulted in a 25% increase in the production of exfoliated vermiculite. The W. R. Grace & Co., Prince Georges County plant, also sold vermiculite for use in concrete aggregate, fireproofing, block insulation, and for horticulture. The crude vermiculite was imported from outside the State.

Table 6.—Maryland: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	4,971	14,120	5,036	14,670
Bituminous aggregate	2,361	6,494	2,378	6,488
Cement manufacture	2,092	2,533	2,062	2,581
Concrete aggregate	1,733	5,073	2,413	7,280
Macadam aggregate	1,658	4,993	1,667	4,203
Dense-graded roadbase stone	1,506	4,520	1,724	4,423
Riprap and jetty stone	400	1,435	219	787
Surface treatment aggregate	294	850	330	981
Railroad ballast	169	411	116	280
Lime manufacture	32	74	27	68
Other uses[2]	469	6,490	765	8,011
Total[3]	15,683	47,000	16,736	49,772

[1] Includes limestone, traprock, granite, miscellaneous stone, and sandstone.
[2] Includes stone used in whiting, soil conditioning, agricultural limestone, refractory stone, abrasives, other fillers and extenders, mineral food, filter stone (1976), asphalt filler (1976), flux stone, and unspecified uses.
[3] Data may not add to totals shown because of independent rounding.

MINERAL FUELS

Coal (Bituminous).—Production in Maryland for 1977 surpassed 3 million tons, the first since 1926, and it continues to be the most valuable mineral commodity mined in the State accounting for 29% of the State's raw mineral wealth.[4] Strip mining has been the main coal mining technique employed in the western part of the State, but lately new technology and economic change have sparked renewed interest in deep mining.

An increasing number of coal operators are executing the Land Reclamations Committee's revegetation standards for acreage planting and became eligible for early bond release consideration. Close adherence to the reclamation-revegetation plans has permitted the State to release bonds in the minimum amount of time.

Coke and Coal Chemicals.—Bethlehem Steel Corp. operated its 10 coke oven batteries totaling 635 ovens to produce coke for its blast furnaces at Sparrows Point. Byproduct tar, light oil, and ammonia were recovered from the coke oven gas. These byproducts were sold for reprocessing and 20% to 40% of the coke oven gas was returned to the ovens and burned to produce more coke.

Natural Gas and Petroleum.—Columbia LNG Corp., a subsidiary of the Columbia Gas Systems, Inc., continued construction of a liquefied natural gas (LNG) import terminal at Cove Point scheduled for completion in 1978. The offshore platform of the terminal is about 1/2-mile long and 2 miles offshore and is to be capable of mooring two LNG carriers simultaneously. During normal operations, a ship will be unloaded in about 12 hours. Pumps will force the LNG through buried piping to onshore tanks, a distance of about 2 miles including the 6,400-foot underwater tunnel.

Each of the four onshore storage tanks holds 375,000 barrels of LNG, about one-half of the cargo of an LNG carrier. As new supplies of LNG arrive, liquid from the storage tanks is to be pumped to the process area, where it will be revaporized into natural gas. The vaporizers are banks of tubes submerged in a bath of agitated warm water and heated by gas burners. As the liquid converts to gas, it will flow directly into a transmission pipeline for delivery to market. To carry the gas from Cove Point to customers, new pipelines are being constructed and connected to pipeline systems supplying Columbia and Consolidated Natural Gas Co. service areas.

METALS

Aluminum.—Although bauxite or other aluminum ore is not mined in Maryland, a significant amount of metallic aluminum is produced at two facilities in the State—Eastalco Aluminum Co. (Howmet Corp.) in Frederick County and Tomke Aluminum Co. in Baltimore County. At the Eastalco plant, site preparation work was initiated in 1977 after environmental and construction permits were obtained for a third potline. Alumax, Inc., is to own 65% of the potline, which is to have a capacity of 91,000 tons per year, and Mitsui & Co., Ltd., is to own the rest. The metal to be produced by the additional capacity is to be used to meet the growing market requirements of the 1980's.

The Maryland Bureau of Air Quality Control (AQC) and Eastalco Aluminum Co. have been formulating an agreement to correct pollution problems at the plant's bake oven and casthouse and thus avoid involved and expensive court litigation. The State's clean air officials and attorney general's office have written a delayed compliance schedule for Eastalco to follow the correct emission control shortcomings uncovered in July 1977 by the AQC investigators. The compliance schedule allowed the company until March 1, 1978, to complete purchase orders for the equipment and until July 1, 1979, to install it.

The agreement requires Eastalco to install baghouse equipment on its bake oven building, similar to that attached to its potlines to keep fluorides and other emissions from escaping the plantsite. A new casting process is being required in the casthouse to eliminate periodic emissions which occur whenever a solid flux is added to molten aluminum metal. Under the new control orders, the fluxing would be controlled in a degassing box.

Copper.—Kennecott Refining Corp. at Hawkins Point, Anne Arundel County, is the only copper refinery now operating in the State.

Iron and Steel.—Bethlehem Steel Corp.'s Sparrows Point plant continues to be one of the largest steel plants in the United States. In 1977, the last two of five 265,000-deadweight-ton tankers, the largest ships ever built in the United States, were built at the company's shipyard.

During 1977, the company had under construction a $200 million 8,000- ton-per-day blast furnace. This facility will be the first in the United States of the world's new generation of furnaces.

Lead.—Five companies in Baltimore County purchased 488 tons of secondary lead in 1977 (contained in soft lead, antimonial lead, and lead in alloys) which was smelted and used in producing type metal, cable covering, solder, and annealing. The list of producers was headed by Industrial Metal Melting Co. Inc., and followed by Signode Corp., Western Electric Co. Inc., Crown Cork & Seal Co. Inc., and Locke Insulators Inc.

Hearings were held by the Occupational Safety and Health Administration (OSHA) in the spring of 1977 on a proposed standard for lead in air inside plants to control health hazards for workers. The proposal would reduce the current limit of 200 micrograms of lead per cubic meter of air to 100 micrograms per cubic meter based on an 8-hour average. An additional hearing was held in November to take testimony about job security for workers moved to other jobs to preserve their health after exposure to lead. EPA in December proposed an ambient air quality standard for lead of 1.5

micrograms per cubic meter by 1982. Although the major source of lead in air is gasoline, the proposed restriction may require control of fugitive lead emissions from smelters, according to EPA.

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[2] Program assistant, State Liaison Office, Maryland and Delaware, Bureau of Mines, Washington, D.C.

[3] Campbell, W. J., R. L. Blake, L. L. Brown, E. E. Cather, and J. J. Sjoberg. Selected Silicate Minerals and Their Asbestiform Varieties. Mineralogical Definitions and Identification-Characterization. BuMines IC 8751, 1977, 56 pp.

[4] Maryland Bureau of Mines. Fifty-fifth Annual Report, Calendar Year 1977.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Portland:			
Alpha Portland Cement Co.[1]	15 South 3d St. Easton, PA 18042	Plant	Frederick.
Lehigh Portland Cement Co.[2]	718 Hamilton St. Allentown, PA 18101	do	Carroll.
Portland and masonry:			
Marquette Cement Manufacturing Co.[1]	First American Center Nashville, TN 37238	do	Washington.
Masonry:			
M. J. Grove Lime Co.[1]	Frederick, MD 21701	do	Frederick.
Clays:			
Baltimore Brick Co	501 St. Paul Pl. Baltimore, MD 21202	Pits	Baltimore and Frederick.
Cyprus Industrial Materials Co.	555 South Flower St. Los Angeles, CA 90071	Pit	Baltimore.
Victor Cushwa & Sons, Inc	201 West Potomac St. Williamsport, MD 21795	Pit	Washington.
Coal:			
Buffalo Coal Co	Box 275 Bayard, WV 26707	5 strip mines	Garrett.
Grafton Coal Co	Box 188 Mountain Lake Park, MD 21550	3 strip mines	Do.
Moran Coal Co., Inc	Drawer E Westernport, MD 21562	Strip mine	Do.
Winner Bros. Coal Co., Inc.	Box 300 Frostburg, MD 21532	5 strip mines	Allegany.
Gypsum (calcined):			
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	Plant	Baltimore.
United States Gypsum Co.	101 South Wacker Dr. Chicago, ILL 60606	do	Do.
Iron oxide pigments, finished (natural and manufactured):			
Minerals Pigments Corp	7011 Muirkirk Rd. Beltsville, MD 20705	do	Prince Georges.
Lime:			
S. W. Barrick & Sons, Inc	Woodsboro, MD 21798	do	Frederick.
Peat:			
Garrett County Processing & Packaging Corp.	R.F.D. No. 1 Accident, MD 21520	Bog	Garrett.
Petroleum refineries:			
Amoco Oil Co	910 South Michigan Ave. Chicago, ILL 60680	Refinery	Baltimore.
Chevron Asphalt Co	Baltimore, MD 21200	do	Do.
Sand and gravel:			
Campbell Sand and Gravel, Inc	4911 Calvert Rd. College Park, MD 20740	Pit	Prince Georges.
Charles City Sand & Gravel Co., Inc.	Waldorf Industrial Center Box 322 Waldorf, MD 20601	Dredges	Charles.
Contee Sand & Gravel Co., Inc	Box 460 Laurel, MD 20810	Pit	Prince Georges.
Harry T. Campbell and Sons Co., a division of The Flintkote Co.	White Marsh Plant Towson, MD 21225	Pits	Baltimore.
York Building Products Co., Inc.	Box 1708 York, PA 17405	Pit	Cecil.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Arundel Corp	501 St. Paul Pl. Baltimore, MD 21202	Quarries	Baltimore, Harford, Howard.
Martin-Marietta Aggregates	66 Long Clove Rd. Congers, NY 10920	Quarry	Washington.
Maryland Materials, Inc	Box W North East, MD 21901	do	Cecil.
Rockville Crushed Stone, Inc.	Box 407 Rockville, MD 20850	do	Montgomery.
D. M. Stoltzfus & Sons, Inc	Talmage, PA 17580	Quarries	Cecil and Harford.

[1] Also stone.

[2] Also clays and stone.

The Mineral Industry of Massachusetts

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the State Geologist of the Commonwealth of Massachusetts for collecting information on all minerals except fuels.

By William R. Barton[1] and Joseph A. Sinnott[2]

The value of minerals produced in Massachusetts increased 11% during 1977, according to the Federal Bureau of Mines. The 1977 value of $77.3 million compared with $69.8 million in 1976 was the result of quantitative increases reported for all major mineral products.

Massachusetts ranked 43d among the States in total value of mineral products. Nonetheless, the State is the site of important production of both dimension and crushed stone (fourth largest producer of dimension granite), lime, and sand and gravel. Some Massachusetts granite is of national reputation as are some quality lime products. Crushed traprock serves not only local needs, but is also shipped to other Northeastern States. Gypsum products (produced in Charlestown), bricks made from Massachusetts clays, and lightweight aggregates from Massachusetts shale enter New England markets. Sand and gravel production is essential to the needs of the Massachusetts construction industry. In order of declining value, the principal indigenous mineral products are stone, sand and gravel, lime, clay and shale, peat, and gem stones.

Massachusetts is self-sufficient only in sand and gravel, and some varieties of stone and clay. It also provides for part of its own requirements for lime. The Commonwealth must rely on imports for most chemical raw materials and other nonmetallic minerals, all metals, and all mineral fuels. About $13 worth of minerals are produced annually per capita in Massachusetts compared with a national average of $356; the value of mineral product per square mile is $9,358, compared with a national average of about $21,324.

Despite the competitive disadvantages

Table 1.—Mineral production in Massachusetts[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	126	$238	149	$275
Lime do	178	6,354	W	W
Sand and gravel do	16,084	29,666	16,639	34,346
Stone do	7,937	33,502	8,093	35,357
Combined value of gem stones, peat, and lime (1977)	XX	90	XX	7,290
Total	XX	69,850	XX	77,268
Total 1967 constant dollars	XX	35,840	XX	[p]38,139

[p]Preliminary. W Withheld to avoid disclosing company proprietary data; included in "Combined value." XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

inherent with a lack of local mineral raw materials, much of Massachusetts' manufacturing activity involves processing or finishing of products made either directly from minerals or from mineral-derived products. Such activities in Massachusetts include gypsum products, brick and glass, concrete products, roofing products, chemicals, plastics, rubber, firearms, abrasives, metal working and fabrication, machine tools and dies, ordnance, hardware, and tools. In addition, most construction activity is heavily dependent upon the use of mineral products.

A measure of the total significance of minerals and mineral products to the Massachusetts economy may be derived by studying the gross State product (GSP) figures issued annually by the Federal Reserve Bank of Boston. While mining represents only 0.1% of the GSP, construction (dependent upon the availability of mineral materials) is more than 3% and manufacturing is more than 25% of the GSP. The latter sector of the economy is itself madeup of 13% stone, clay, glass, and primary and fabricated metal manufacture; 36% machinery, electrical and electronic components, motor vehicles, and ordnance and transport; and 9% chemicals, rubber, and plastics. All of these categories are dependent upon mineral-derived products, either entirely or in part. Even organic chemical or plastic products may be more than 50% mineral filler or extender in some cases.

Approximately 2,400 of Massachusetts' 1.9 million industry workers were employed at the site of mining operations. An additional 69,000 persons were engaged in construction; and of the more than 600,000 in manufacturing; 76,000 were employed in the production of stone, clay, glass, primary metals and fabricated metal products. Other manufacturers that rely upon mineral-derived materials were estimated to employ an additional 227,000 persons.

Minerals and mineral products are also important to the rail and truck industries of Massachusetts. Crushed traprock from Massachusetts is carried by train throughout the Northeast for use as a preferred rail roadbed ballast. Dimension and crushed stone, lime, and sand and gravel are important items of both intrastate and interstate commerce. U.S. Gypsum trucks are a familiar sight on New England highways transporting gypsum products from the Charlestown plant to construction sites and materials dealers throughout the region.

The maritime commerce of Massachusetts is dependent upon mineral- related trade for continued harbor operations. For example, of the 26,172,442 tons of cargo moved through the Port of Boston in 1976, 91% was classified as mineral fuels or fuel-related products. The remaining 2,241,280 tons of freight included 689,416 tons of nonmetallic minerals and nonmetallic mineral products, 39,785 tons of metallic ores, metals, and primary metal products, and 354,796 tons of metal scrap. Cumulatively, 96% of the freight traffic was directly mineral-industry or mineral-product related (including energy mineral products).

The Federal Bureau of Mines sponsored research into the extent and quality of Narragansett Basin anthracite reserves by Weston Observatory-Boston College and Charles River Associates. During fiscal year 1978, contracts of $240,000 and $48,000 were placed with the two groups. Stress in the two studies was placed upon the legal, environmental, economic, and societal aspects involved in any future development of Massachusetts anthracite reserves. The Bureau of Mines also published a summary of in-house work to date on analytical and coal-cleaning studies on the anthracite as Information Circular 8760 "Anthracite in the Narragansett Basin of Rhode Island and Massachusetts."

Disposal and recycling of wastes are of great concern in Massachusetts. Etching and plating wastes from metal-working establishments constitute a difficult environmental and disposal problem. Several Bureau of Mines research centers are at work devising improved methods for handling and reclaiming such wastes, and the Bureau has invited State officials to nominate most urgent areas as subjects for Bureau research efforts.

The Massachusetts State Geologist has a Memorandum of Understanding with the Federal Bureau of Mines under which the Bureau provides free analytical support for his ongoing projects.

The Massachusetts legislature passed a bill to regulate coal mining. Although there is no coal mining in Massachusetts at present, nor is any imminently contemplated, the new law was drafted to avoid any possible future development of coal mine-related problems that have been encountered in other States. Provisions of the bill will be enforced by the Department of Environmental Quality Engineering.

Massachusetts has completed a plan for

managing coastal lands and waters and submitted it to the U.S. Department of Commerce for approval. The draft plan affirms a continuing moratorium on mining in Massachusetts coastal waters and will have additional impact upon onshore mineral extraction within the coastal zone by mandating new land use requirements beyond those promulgated by local zoning, planning, and conservation authorities.

Massachusetts became the first State to pass a law assisting communities to buy development rights to farmland. Under the new law, all industrial uses, including mining, would be forever prohibited on restricted-use properties.

Table 2.—Value of mineral production in Massachusetts, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Barnstable	$1,111	$1,603	Sand and gravel.
Berkshire	15,870	W	Stone, lime, sand and gravel.
Bristol	5,316	6,730	Stone, sand and gravel.
Dukes	105	98	Sand and gravel.
Essex	6,734	6,965	Stone, sand and gravel.
Franklin	W	1,617	Sand and gravel, stone.
Hampden	W	4,700	Stone, sand and gravel.
Hampshire	W	W	Sand and gravel, stone.
Middlesex	15,232	15,541	Stone, sand and gravel.
Nantucket	W	100	Sand and gravel.
Norfolk	W	W	Stone, sand and gravel, clays.
Plymouth	W	W	Sand and gravel, clays, stone.
Suffolk	W	W	Stone.
Worchester	W	W	Sand and gravel, stone, peat.
Undistributed[1]	25,483	39,912	
Total[2]	69,850	77,268	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes gem stones.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Massachusetts business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,753.0	2,780.0	+1.0
Unemployment	do	262.0	225.0	-14.1
Employment (nonagricultural):				
Mining	do	([1])	([1])	--
Manufacturing	do	592.9	608.0	+2.5
Contract construction	do	71.6	68.9	-3.8
Transportation and public utilities	do	112.1	111.8	-.3
Wholesale and retail trade	do	521.1	536.1	+2.9
Finance, insurance, real estate	do	135.2	136.1	+.7
Services	do	[2]509.7	[2]530.9	+4.2
Government	do	366.5	371.7	+1.4
Total nonagricultural employment	do	2,309.1	2,363.5	+2.4
Personal income:				
Total	millions	$38,414	$41,964	+9.2
Per capita		$6,633	$7,258	+9.4
Construction activity:				
Number of private and public residential units authorized		18,201	21,978	+20.8
Value of nonresidential construction	millions	$354.4	$482.0	+36.0
Value of State road contract awards	do	$145.0	$120.0	-17.2
Shipments of portland and masonry cement to and within the State	thousand short tons	846	895	+5.8
Mineral production value:				
Total crude mineral value	millions	$69.8	$77.3	+10.6
Value per capita, resident population		$12	$13	+8.3
Value per square mile		$8,459	$9,358	+10.6

[p] Preliminary.

[1] Included with "Services."

[2] Includes mining.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the Massachusetts mineral industry in 1977[1]

	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate	Non-disabling injuries	Non-disabling injury frequency rate
Sand and gravel:								
Surface	1,231	1,595,551	--	--	5	3.13	4	2.51
Office	233	293,220	--	--	--	--	--	--
Total	1,464	1,888,771	--	--	5	2.65	4	2.12
Stone:								
Surface	379	648,874	--	--	22	33.90	3	4.62
Mill	388	809,935	--	--	8	9.88	--	--
Office	128	240,082	--	--	--	--	--	--
Total	895	1,698,891	--	--	30	17.66	3	1.77
Clays:								
Surface	14	25,425	--	--	--	--	--	--
Mill	12	21,680	--	--	--	--	--	--
Office	3	4,640	--	--	--	--	--	--
Total	29	51,745	--	--	--	--	--	--
Peat:								
Surface	6	7,041	--	--	--	--	--	--
Office	1	280	--	--	--	--	--	--
Total	7	7,321	--	--	--	--	--	--
State total:								
Surface	1,630	2,276,891	--	--	27	11.86	7	3.07
Mill	400	831,615	--	--	8	9.62	--	--
Office	365	538,222	--	--	--	--	--	--
Grand total	2,395	3,646,728	--	--	35	9.60	7	1.92

[1] Data supplied by Mine Safety and Health Administration, U.S. Department of Labor.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement is not produced in Massachusetts. In 1977, domestic producers shipped 858,546 tons of finished portland cement and 36,414 tons of prepared masonry cement into the State, compared with the equivalent 1976 figures of 810,545 and 34,704 tons, respectively.

Clay and Shale.—Common clay and shale production in 1977 increased 18% in tonnage and 16% in value, compared with the 1976 level. The principal producers of brick and common clay products were K-F Brick Co., Inc. (Susquehanna Corp.), at Middleboro, and Stiles & Hart Brick Co. at Bridgewater. The Masslite Division of Plainville Corp. produced expanded lightweight aggregate for use in concrete products from mixed shales and anthracite of the Carboniferous Narragansett Basin.

Gem Stones.—Small amounts of gem stones and specimens were collected by hobbyists. Amethyst from Bellingham has been of particular interest in recent years. The world's largest synthetic sapphires (40-pound crystals) are made at Crystal Systems, Inc., in Salem.

Graphite.—Small quantities of synthetic graphite were reported produced in Massachusetts.

Gypsum.—United States Gypsum Co. calcined raw gypsum from Canada at Charlestown (Boston) in Suffolk County. Output of gypsum products increased from the 1976 level.

Lime.—Pfizer, Inc., and Lee Lime Corp. produced lime in Berkshire County for food products, precipitated calcium carbonate, mason's lime, sewage treatment, and other uses. Production increased over that of the previous year. The lime was used in Massachusetts, New York, Connecticut, and other States.

Peat.—Reed-sedge peat was mined by Sterling Peat Co. in Worcester County. The peat was used mainly by nurserymen, landscapers, and greenhouse owners.

Perlite (Expanded).—Crude perlite mined outside the State was expanded at two plants in Suffolk County that sold the product mainly for lightweight aggregate, low-temperature insulation, masonry and cavity fill insulation, and horticultural aggregate.

Roofing Aggregate.—Output of rhyolite to make roofing granules decreased slightly. The rhyolite is quarried in Norfolk County and for statistical purposes is classified as miscellaneous stone.

Sand and Gravel.—Sand and gravel production in 1977 increased 3% in quantity and 16% in value, compared with that of 1976. The 16.6 million tons of sand and gravel produced was 44% of the total value of mineral output in Massachusetts, making sand and gravel second only to stone as a mineral commodity produced in the Commonwealth. There were 186 sand and gravel operations reported, 3 of which produced industrial sands.

Sand and gravel production was reported from all counties in the State except Suffolk. Building and paving markets consumed the major portion of the production. Industrial sand was used for molding, blasting, and filtration.

During the year there were numerous local controversies over gravel removal permits. Many applications were denied outright by local zoning or conservation bodies, and others were amended to make conditions under which mining could proceed far more stringent. The result was a continued upward trend in the prices for mineral aggregates used in construction.

Stone.—Stone production increased 2% in tonnage and 6% in value in 1977. Stone with a value of $35.4 million, was the leading mineral product in value in Massachusetts in 1977, contributing 46% of the value of the State's total mineral product.

Dimension stone production declined 24% to 62,600 tons valued at $4.9 million; crushed and broken stone increased 2% to 8 million tons valued at $30.1 million.

Stone, produced in 44 quarries in 11 counties, included basalt, granite, limestone, dolomite, and miscellaneous stone. Basalt was the most important stone in both quantity and value. Crushed and broken stone accounted for 99% of the total stone quantity in 1977 and 86% of total value.

Table 5.—Massachusetts: Sand and gravel sold or used by producers, by use

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	9,214	$13,361	$1.45	6,912	$13,761	$1.99
Gravel	6,785	15,685	2.31	9,609	19,633	2.04
Total[1]	16,000	29,046	1.82	16,520	33,395	2.02
Industrial:						
Sand	83	615	7.41	119	951	7.99
Gravel	2	4	2.00	--	--	--
Total	85	619	7.28	119	951	7.99
Grand total or average[1]	16,084	29,666	1.84	16,639	34,346	2.06

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Massachusetts: Construction sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	5,378	$12,357	$2.30	6,654	$15,754	$2.37
Concrete products (cement blocks, bricks, pipe, etc.)	896	1,983	2.21	1,046	2,620	2.50
Asphaltic concrete aggregates and other bituminous mixtures	1,753	3,597	2.05	1,414	3,437	2.43
Roadbase and coverings	3,410	4,880	1.43	3,368	5,894	1.75
Fill	3,732	4,524	1.21	3,467	4,444	1.28
Railroad ballast[1]	--	--	--	W	W	2.82
Other uses	830	1,705	2.05	571	1,246	2.17
Total or average	[2]16,000	29,046	1.82	16,520	33,395	2.02

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Railroad ballast included with "Other uses."

[2] Data do not add to total shown because of independent rounding.

Crushed and broken stone producers were the quantity leaders in the stone field. They included John S. Lane & Son, Inc., Warren Bros. Co., a division of Ashland Oil & Refining Co., and Simeone Stone Corp. The value leaders, however, were H. E. Fletcher Co., a producer of granite dimension stone, and Pfizer, Inc., a producer of ground limestone (marble) products. Both products have much higher unit values than stone for construction aggregate.

Among the States, Massachusetts ranked fourth in output of dimension granite, fourth in crushed traprock, and eighth in total output of dimension stone.

The Roma Stone Corp. started operation of a crushed stone quarry in Woburn near the juncture of Interstate 93 and the Boston Beltway (I-95). The operation will produce 800,000 tons of stone in 4 years and level a small hill. The newly created flat land will then be recycled as a prime industrial site.

Vermiculite.—The quantity and value of the vermiculite processed in Massachusetts during 1977 increased slightly. W. R. Grace & Co. in Hampshire County exfoliated vermiculite mined outside the State. The material was used mainly as insulation; other uses were, in order of production, concrete aggregate, soil conditioning, and plaster.

Table 7.—Massachusetts: Production of crushed stone,[1] by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Bituminous aggregate	3,024	9,455	3,103	10,710
Roadstone	1,136	2,738	1,466	4,060
Dense-graded roadbase stone	720	1,957	760	2,194
Railroad ballast	646	1,348	752	1,615
Concrete aggregate	541	1,448	632	1,712
Filter stone	283	855	245	818
Roofing granite	167	472	173	W
Agricultural limestone	138	1,021	134	996
Macadam aggregate	127	399	101	360
Riprap and jetty stone	227	695	81	216
Surface treatment aggregate	167	429	10	30
Other uses[2]	678	7,331	573	7,794
Total[3]	7,855	28,150	8,030	30,501

[1] Includes traprock, granite, limestone, and miscellaneous stone.

[2] Includes stone used in lime manufacture, fill, other filler (1977), whiting (1976), mineral food, asphalt filler, flux stone, unspecified uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

METALS

Scrap.—Matcon Recycling, Inc., began recycling municipal refuse at Salem. The firm recovered 400 tons of metal per month, mostly tin cans for detinning. Other products included scrap aluminum, glass, and paper.

Uranium.—The Department of Energy revealed tentative plans to test the Connecticut Valley of Massachusetts for uranium potential. However, it was unclear when funding would be available to implement the plan.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
K-F Brick Co., Inc. (Susquehanna Corp.)	River St. Middleboro, MA 02346	Pit	Plymouth.
Plainville Corp., Masslite Div.[1]	Box 327 Walpole, MA 02081	Pit	Norfolk.
Stiles & Hart Brick Co	Box 367 Bridgewater, MA 02324	Pit	Plymouth.
Gypsum, calcined:			
United States Gypsum Co.[2]	101 South Wacker Dr. Chicago, IL 60606	Plant	Suffolk.
Lime:			
Lee Lime Corp.[3]	Marble St. Lee, MA 01238	do	Berkshire.
Pfizer, Inc.[3]	260 Columbia St. Adams, MA 01220	do	Do.
Peat:			
Sterling Peat Co	Sterling Junction, MA 01565	Bog	Worcester.
Perlite, expanded:			
Whittemore Products, Inc	35 Harrison St. Roslindale, MA 02131	Plant	Suffolk.
Roofing granules:			
Bird & Son, Inc	49 Washington St. East Walpole, MA 02032	do	Norfolk.
Sand and gravel:			
Construction:			
Assabet Sand & Gravel	Box 256 Acton, MA. 01720	Pit	Middlesex.
J. J. Cronin Co	Box 176 North Reading, MA 01864	Pit	Do.
E. L. Dauphinais, Inc	160 Worcester Rd. North Grafton, MA 01536	Pit	Worcester.
Hyannis Sand & Gravel, Inc	Box 96 Hyannis, MA 02601	Pit	Barnstable.
Marshfield Sand & Gravel, Inc	Clay Pit Rd. Marshfield, MA 02050	Pit	Norfolk.
Merrimack Paving Corp	Yemma Rd. Groveland, MA 01830	Pit	Essex.
Namasket Construction Co	Box 296 Middleboro, MA 02341	Pit	Plymouth.
A. A. Will Sand & Gravel Corp	Turnpike St. Canton, MA 02021	Pit	Norfolk.
Worcester Sand & Gravel Co	182 Holden St. Shrewsbury, MA 01545	Pit	Worcester.
Industrial:			
Holliston Sand Co., Inc	303 Lowland St. Holliston, MA 01746	Pit	Middlesex.
Southeastern Sand & Gravel Inc	Kingston, MA 02364	Pit	Plymouth.
Whitehead Bros. Co	60 Hanover Rd. Florham Park, NJ 07932	Pit	Do.
Stone:			
G. Brox, Inc	1471 Methuen St. Dracut, MA 01826	Quarry	Middlesex.
Essex Bituminous Concrete, Inc	55 Russell St. Peabody, MA 01960	do	Essex and Middlesex.
H. E. Fletcher Co	West Chelmsford, MA 01863	do	Middlesex and Worcester.
John S. Lane & Son, Inc	Box 125 Westfield, MA 01085	do	Hampden and Hampshire.
P. J. Keating Co	Box 367 Fitchburg, MA 01420	do	Worcester.
Lynn Sand & Stone Co	30 Danvers Rd. Swampscott, MA 01907	do	Essex.
Manchester Stone & Gravel Co	Box 402 Manchester, MA 01944	do	Do.
Massachusetts Broken Stone Co	133 Boston Post Rd. Weston, MA 02193	do	Middlesex.

See footnotes at end of table.

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[1] State Liaison Officer, Bureau of Mines, Newmarket, N.H.

[2] Massachusetts State Geologist, Boston, Mass.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone: —Continued			
Old Colony Crushed Stone Co	Box 230 Quincy, MA 02169	Quarry	Norfolk.
Simeone Stone Corp	1185 Turnpike St. Soughton, MA 02072	do	Do.
Trimount Bituminous Products Co	1840 Revere Beach Pkwy. Everett, MA 02149	do	Essex.
Warren Bros. Co., a division of Ashland Oil & Refining Co.	430 Howard St. Brockton, MA 02402	do	Bristol.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Hampshire.

[1] Also sand and gravel.
[2] Also expanded perlite.
[3] Also stone.

The Mineral Industry of Michigan

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey Division of the Michigan Department of Natural Resources, under a Memorandum of Understanding for collecting information on all minerals except coal and liquid fuels.

By Edward C. Peterson[1] and Esther A. Middlewood[2]

Michigan's mineral production in 1977 was valued at $1.6 billion, a 5% increase over that of 1976. Record production of oil and gas was offset by a 26% drop in iron ore production. Crude oil was the principal mineral commodity in value, followed by iron ore, cement, natural gas, sand and gravel, and stone.

Significant events in the mineral industry during the year included a lengthy strike by 3,400 members of the United Steelworkers of America against the Cleveland-Cliffs Iron Co. (CCI). The work stoppage closed the company's iron mines between August 1 and November 23, resulting in a sharp decline in iron ore shipments for the year.

Inland Steel Co. announced plans for phasing out operations at its Sherwood underground iron mine in Iron River. Production is expected to continue until mid-1978, although shipments from stockpile are scheduled through the 1981 shipping season.

Startup of a giant casting machine that can continuously cast the widest steel slabs in the world was announced by National Steel Corp.'s Great Lakes Steel Div. in Detroit. The facility, estimated to cost over $60 million, is designed to cast slabs measuring 104 inches wide by 12 inches thick.

Exploration.—The U.S. Geological Survey, in cooperation with the Geological Survey Div. of the Michigan Department of Natural Resources (DNR), completed detailed studies of iron-bearing rocks in the Marquette and Gogebic iron ranges in the Upper Peninsula during 1977. The lengthy study, conducted over a 20-year period, included mapping the surface distribution of the iron-bearing rocks. Only the taconite, for which both mining and upgrading by concentrating techniques is required to produce a usable product, was considered. According to the study, the resources of this material in Michigan are large, but only about 1% of them can be considered reserves (profitably minable at present).[3]

The Institute of Mineral Research at Michigan Technological University, in cooperation with both the U.S. Geological Survey and Michigan's DNR, continued geologic studies of an area about 40 miles northwest of Marquette, where earlier testing prompted scientists to announce that potentially important deposits of rocks rich in the phosphate mineral apatite may occur. One diamond core hole was drilled in the area to provide samples for analysis. No results of the study had been announced at yearend.

Exploration for uranium by several mining companies and governmental agencies continued in the Upper Peninsula during 1977. Exploration by the Tennessee Valley Authority (TVA) with American Copper & Nickel Co., a subsidiary of International Nickel Co., consisted of aerial reconnaissance, surface examination, and test drilling over thousands of acres. A report from the firm contracted to do the exploration

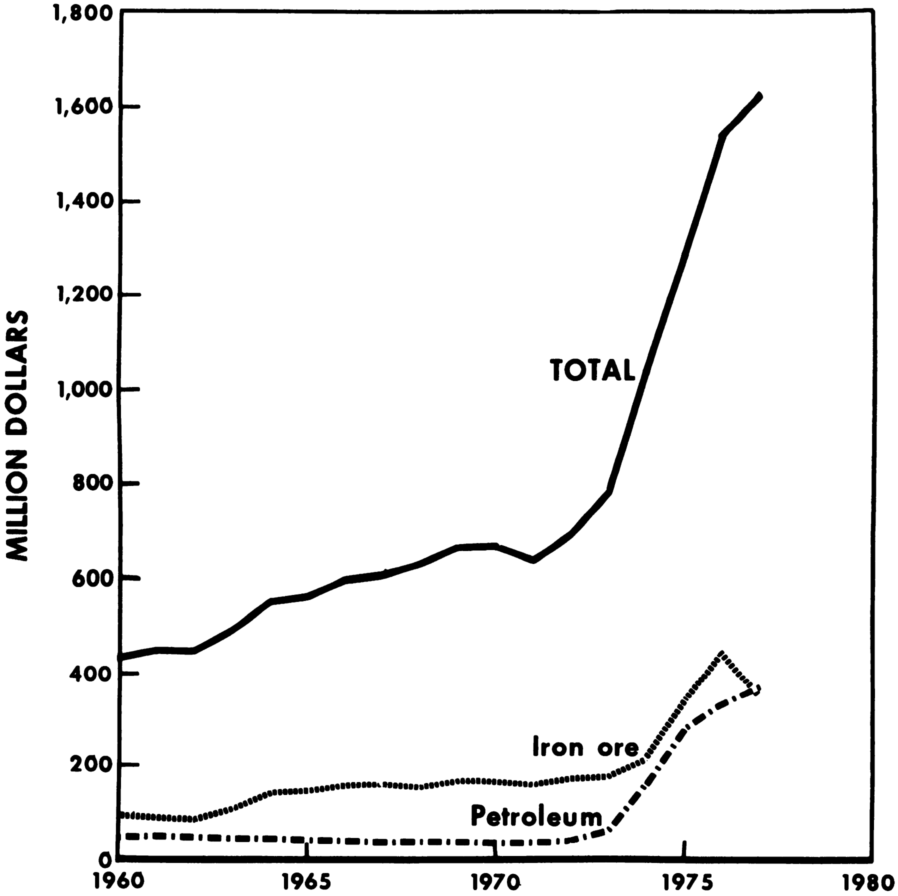

Figure 1.—Value of iron ore, petroleum, and total value of mineral production in Michigan.

Table 1.—Mineral production in Michigan[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	218	$8,370	246	$9,761
Portland do	4,931	145,381	5,582	166,803
Clays do	1,934	4,741	2,007	5,126
Copper (recoverable content of ores, etc.) short tons	43,707	60,840	42,375	56,613
Gem stones	NA	10	NA	12
Gypsum thousand short tons	1,837	9,842	1,924	8,778
Iron ore (usable), thousand long tons gross weight	16,245	441,206	12,009	356,227
Lime thousand short tons	1,456	39,686	1,347	42,015
Natural gas million cubic feet	119,262	106,739	129,954	131,254
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels	3,504	19,725	7,919	73,675
LP gases do	1,215	6,306		
Peat thousand short tons	r280	r3,397	226	3,917
Petroleum (crude) thousand 42-gallon barrels	30,421	329,637	32,965	362,722
Salt thousand short tons	4,219	79,740	3,939	78,808
Sand and gravel do	47,403	78,455	46,486	101,542
Silver (recoverable content of ores, etc.) thousand troy ounces	311	1,352	335	1,550
Stone thousand short tons	41,485	82,331	40,525	85,118
Combined value of bromine, calcium chloride, iodine, and magnesium compounds	XX	r128,557	XX	138,626
Total	XX	r1,546,315	XX	1,622,547
Total 1967 constant dollars	XX	793,723	XX	p800,889

pPreliminary. rRevised. NA Not available. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Michigan, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Alcona	$187	$46	Sand and gravel.
Alger	207	50	Do.
Allegan	2,174	W	Sand and gravel, stone, peat.
Alpena	65,116	W	Cement, stone, clays, sand and gravel.
Antrim	W	W	Clays, sand and gravel.
Arenac	W	1,231	Stone, sand and gravel.
Baraga	183	271	Sand and gravel.
Barry	W	905	Sand and gravel, stone.
Bay	14,115	12,881	Cement, sand and gravel, lime.
Benzie	W	45	Sand and gravel.
Berrien	5,095	7,050	Do.
Branch	217	W	Sand and gravel, stone.
Calhoun	21,716	959	Do.
Cass	W	1,082	Sand and gravel.
Charlevoix	W	W	Cement, stone, sand and gravel.
Cheboygan	W	W	Stone, sand and gravel.
Chippewa	W	W	Do.
Clare	W	436	Sand and gravel.
Clinton	W	W	Sand and gravel, clays.
Crawford	W	73	Sand and gravel.
Delta	W	659	Sand and gravel, stone.
Dickinson	W	W	Iron ore, sand and gravel, stone.
Eaton	8,239	W	Sand and gravel, stone, clays, peat.
Emmet	15,520	W	Cement, stone, clays, sand and gravel.
Genesee	W	W	Sand and gravel.
Gladwin	W	15	Do.
Gogebic	158	242	Do.
Grand Traverse	67,787	258	Do.
Gratiot	11,097	W	Calcium chloride, magnesium compounds, salt, sand and gravel.
Hillsdale	19,448	882	Sand and gravel.
Houghton	2,959	344	Sand and gravel, stone.
Huron	W	W	Stone, lime, sand and gravel.
Ingham	31,913	1,286	Sand and gravel, peat.
Ionia	407	195	Sand and gravel.
Iosco	W	W	Gypsum, sand and gravel.
Iron	W	W	Iron ore, sand and gravel.
Isabella	W	1,018	Sand and gravel.
Jackson	W	W	Sand and gravel, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Michigan, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Kalamazoo	W	$2,169	Sand and gravel.
Kalkaska	$80,471	6	Do.
Kent	5,117	W	Sand and gravel, gypsum, peat.
Keweenaw	36	--	
Lake	W	75	Sand and gravel.
Lapeer	3,654	W	Sand and gravel, peat, calcium chloride.
Leelanau	W	W	Sand and gravel.
Lenawee	1,021	1,149	Do.
Livingston	W	3,113	Do.
Luce	W	120	Do.
Mackinac	13,354	14,919	Stone, sand and gravel.
Macomb	W	2,499	Sand and gravel.
Manistee	126,365	70,213	Magnesium compounds, salt, sand and gravel, bromine.
Marquette	W	W	Iron ore, sand and gravel, stone.
Mason	[r]69,763	W	Calcium chloride, magnesium compounds, lime, bromine, sand and gravel.
Mecosta	723	W	Sand and gravel, peat.
Menominee	76	118	Sand and gravel.
Midland	[r]33,849	W	Bromine, calcium chloride, magnesium compounds, salt, iodine.
Missaukee	7,496	248	Sand and gravel.
Monroe	33,099	35,209	Cement, stone, clays, peat.
Montcalm	W	1,004	Sand and gravel.
Montmorency	W	--	
Muskegon	W	W	Sand and gravel, salt.
Newaygo	W	W	Sand and gravel.
Oakland	18,505	20,238	Sand and gravel, peat.
Oceana	W	2,808	Sand and gravel.
Ogemaw	6,731	380	Do.
Ontonagon	59,550	58,388	Copper, silver, sand and gravel.
Osceola	3,937	530	Sand and gravel.
Oscoda	W	--	
Otsego	78,812	38	Sand and gravel.
Ottawa	W	5,138	Do.
Presque Isle	W	35,512	Stone, sand and gravel.
Roscommon	4,443	--	
Saginaw	W	W	Sand and gravel, lime.
St. Clair	47,507	W	Salt, sand and gravel.
St. Joseph	W	W	Sand and gravel, stone, peat.
Sanilac	W	W	Peat, sand and gravel, lime.
Schoolcraft	1,423	1,774	Stone, sand and gravel.
Shiawassee	W	W	Clays, peat, sand and gravel.
Tuscola	2,268	W	Sand and gravel, lime.
Van Buren	W	W	Sand and gravel.
Washtenaw	W	3,319	Do.
Wayne	88,716	91,494	Lime, cement, salt, stone, sand and gravel, clays.
Wexford	W	1,660	Sand and gravel.
Undistributed[2]	[r]592,852	1,240,496	
Total[3]	[r]1,546,315	1,622,547	

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Values of petroleum and natural gas are based on an average price per barrel and cubic foot respectively for the State.

[2] Includes values for gem stones, natural gas, natural gas liquids, petroleum, and some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

indicated that efforts to date have failed to reveal any commercial deposits of uranium. Exxon Co., USA centered its search for uranium in Dickinson County, south of the city of Marquette. No results were announced. Under a grant received from the U.S. Department of Energy (DOE), Michigan's DNR attempted to evaluate potential uranium-producing areas in Marquette County. This project, which essentially consists of drilling for geologic information, fulfills one of the prime objectives of DOE's National Uranium Resource Evaluation Program. The program is aimed at providing geologic data that will improve the information base for assessment of resources and to aid industry exploration efforts.

Transportation.—One of the basic ingredients to a healthy economic climate in any area is efficient transportation of raw materials and finished products. Water transportation on the Great Lakes plays a major role in many of the operations of Michigan's mineral producers and processors. Without the Great Lakes network, moving products to market would be difficult since most rail systems in the State are not geared for the mining industry. The distances between producers and consumers are too great for realistic and practical truck movement.

Five stone quarries, located within a 75-mile radius of the Straits of Mackinac, rely almost exclusively on waterborne transportation to move their products to market.

Table 3.—Indicators of Michigan business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	4,000.0	4,118.0	+2.9
Unemployment do	374.0	337.0	-9.9
Employment (nonagricultural):			
Mining do	12.7	12.2	-3.9
Manufacturing do	1,056.7	1,105.6	+4.6
Contract construction do	105.3	124.1	+17.8
Transportation and public utilities do	144.6	146.9	+1.6
Wholesale and retail trade do	674.7	698.9	+3.6
Finance, insurance, real estate do	136.9	139.5	+1.9
Services do	539.3	570.3	+5.7
Government do	594.0	614.1	+3.4
Total nonagricultural employment do	3,264.2	3,411.6	+4.5
Personal income:			
Total millions	$61,649	$69,554	+12.8
Per capita	$6,765	$7,619	+12.6
Construction activity:			
Number of private and public residential units authorized	45,895	58,684	+27.9
Value of nonresidential construction millions	$599.3	$817.2	+36.4
Value of State road contract awards do	$220.3	$280.0	+27.1
Shipments of portland and masonry cement to and within the state thousand short tons	2,735	2,839	+3.8
Mineral production value:			
Total crude mineral value millions	[r]$1,546.3	$1,622.5	+4.9
Value per capita, resident population	$170	$178	+4.7
Value per square mile	$26,514	$27,871	+5.1

[p] Preliminary. [r] Revised.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

According to the Lake Carriers' Association, iron ore shipments loaded at Great Lakes ports in 1977 consisted of approximately 67 million gross tons, down from the previous year due mainly to the iron ore strike. Michigan accounts for approximately 22% of the total U.S. domestic iron ore shipments.

The State of Michigan approved nearly $400,000 for a study of its 26 commercial ports early in the year. Plans were halted, however, when a State legislator protested the study on the grounds that other studies have already been done. Officials in the Department of State Highways and Transportation contended that a comprehensive study has never been completed. This particular study was to provide a complete picture of ports, their potential, the need for improvements, and how to finance them. Changes in domestic interlake commerce and the use of larger ships to reduce transportation costs have made the study necessary.

The proposed abandonment of some of the rail transportation links in the Upper Peninsula have caused concern among local residents, industry representatives, and government officials. Millions of tons of metallic ores move by rail to shipping points on the Great Lakes, and economic and geologic studies indicate a potential exists for many more millions of tons to be moved in this area. The Lake Superior and Ishpeming Railroad (LS&I) has petitioned the Interstate Commerce Commission for permission to abandon 52.5 miles of track in the Upper Peninsula. The company cited losses on the run as the primary reason for requesting permission to abandon the stretch. Approximately 90% of LS&I's current business consists of shipping iron ore for CCI, owners of about 86% of LS&I's company stock. The other 10% includes shipments of iron ore processing products into the area and the transportation of materials for other nonmineral-related industries. An alternative to the abandonment of the track, including a consolidation of LS&I and Soo Line Railroad is under discussion.

In addition, 92 miles of Milwaukee Road track from Channing to Ontonagon is also under study for possible abandonment. A shorter track, also operated by the Milwaukee Road, has been designated for abandonment sometime within the next 3 years. The railroad currently hauls supplies for a local paper mill, including coal and chemicals. The railroad contends this service is losing money.

The Soo Line Railroad has petitioned for the abandonment of approximately 50 miles of rail between Baraga and Calumet and between Hancock and Lake Linden. These routes have been in operation since 1872, but are no longer making a profit. According to local authorities, the proposal could have serious negative effects on the economy of the Upper Peninsula and also serious long-range effects by wiping out any hope of the rebirth of copper mining in the Houghton area. Although copper mining in the area is dormant, it is mostly due to the low price of the metal on the world market. Any substantial upsurge in price could cause a change in the industry. Companies with interests in the area have indicated they would consider resuming operations if a profit was possible.

In January 1977, Chicago & Northwestern Railway marked the completion of a record-breaking 1976-77 season. The 10-million-ton figure was reached and surpassed for the first time in 113 years of operating iron ore loading facilities in Escanaba. The shipping period closed on January 9, with the final cargo consisting of Empire mine pellets slated for the Indiana Harbor works of Inland Steel Co. During the season, the all time high totaled 10,228,125 gross tons of iron ore products, consisting of 9,922,816 tons of pellets and 305,309 tons of natural ore. The new peak compares with the former record of 9,835,505 tons handled in the previous 1975-76 shipping period.[4]

Legislation and Government Programs.—Michigan legislators continued to be aware of environmental problems and concerns relating to the mining and mineral-processing industries during the year. In a series of legislation, lawmakers dealt with the problem of storing nuclear waste materials in the State and introduced bills aimed at regulating land use, solid waste management, and oil and gas drilling. Only legislation concerning nuclear waste disposal was reported out of committee.

Taxation relating to mining was also under consideration as legislators began studying the present formula of taxing Michigan's iron ore producers to determine if the system was equitable to both companies and local governments. Michigan's Specific Iron Ore Tax, enacted in 1951, is paid by the iron mining companies to local governments in lieu of property taxes. In connection with this proposal, House Concurrent Resolution 81 created a joint committee to study all aspects of Michigan's iron ore industry. A schedule of public hearings was announced at yearend.

House Bill 5451 was introduced as a tax measure during the legislative session. This bill attempted to increase oil and gas severance taxes paid by operators on State lands. At the close of the session the bill had not been reported out of committee.

A 1977 ruling by the State Attorney General blocked efforts by DNR to impose temporary restrictions under Public Act 222 of 1976. According to the decision, sand dune mining may continue without permits until the State is ready to administer the new law regarding such operations. The problem was caused by a delay in implementing the 1976 law that required sand mine operators to get mining permits by July 1977. The DNR, designated as the regulatory agency, had not completed a survey of the areas to be protected under the law. Implementation is expected in 1978.

Michigan's metallic mineral lease program was caught in limbo during the year as requests for further study and the revision of the lease form continued. Under the new proposed lease, tight environmental controls are demanded. Before it can become effective, the new lease form must be approved by the Natural Resources Commission. Meanwhile, applications for lease agreements are being filed in the Lands Div., DNR. No leases for mining of metals on State lands can be issued until the new form is approved.

The U.S. General Accounting Office announced that a Federal program at Battle Creek involving the recovery of gold, silver, and platinum from surplus defense material before it is sold as scrap has lost more than $11 million in the 1977 fiscal year. The program to recover metals was established by the U.S. Department of Defense in 1974 and placed under the direction of the Defense Property Disposal Service in Battle Creek. One major problem faced by the project is identifying the many sources of precious metals within the defense establishment and determining whether salvage is economically feasible. The precious metals are contained in such items as computer parts, batteries, photographic solutions, uniform buttons, and eyeglass frames.

Active Federal Bureau of Mines contracts and grants to educational institutions and private industry in Michigan totaled approximately $2.6 million in 1977. About $2.2 million supported continuing projects from previous years, while $386,000 was awarded for new projects. The contracts and grants involve such subjects as ground control, industrial hygiene, equipment testing, oil shale extraction, and prevention of mine fires and explosions.

In one contract, Michigan Technological University (MTU) received $189,000 to fund a continuing project involving the study of mine air pollutants, particularly diesel pollutants at the White Pine copper mine in Ontonagon County. The overall goal of the research is to provide the measurement and analytical techniques for determining optimum control of air quality for miners' health. In a related project initiated in 1977, MTU received $81,370 to study the amount of gases created on the firing of common usage explosives. This is the first research project to make use of MTU's new experimental mine.

One research project being conducted by the White Pine Copper Co. was completed during the year.[5]

Education.—With the acquisition of an experimental mine in Hancock, MTU mining engineering students gain practical underground experience. In an effort to improve the productivity of copper mines in the area by using mechanized mining systems, the Department of Mining Engineering at MTU acquired the mine for teaching and research projects. If a mechanized system can be properly applied to native copper ores, it could have a favorable economic impact on the area. Approximately 15 students work in the mine each term. The students drill, blast, run the machinery, do maintenance, and perform all jobs necessary to operate a mine. An experienced miner assists in the actual training and makes job assignments. The Board of Control at MTU entered into the lease agreement with the Homestake-Quincy venture and widened the east adit of the Quincy mine so that trucks could enter and underground classroom mines and a laboratory could be established.

At Huron Castings Inc., in Port Huron, trainees learn the forging process through a 6-week training course funded by the Comprehensive Employment and Training Act (CETA), then go on to additional training. Huron Castings began operation toward the end of 1977 and this program aided the company in providing trained employees for the startup. Upon completion of formalized training, the workers entered a period of on-the-job training funded jointly by the Thumb Area Consortium and the Comprehensive Employment Program (CEP) of the Michigan Department of Labor. This was the first venture by CEP into the forging industry. Cost of the training was estimated at approximately $500 per person.[6]

Employment.—Michigan's unemployment figures for 1977 reflected the improved national economic picture. Unemployment during the year averaged 7%, according to preliminary statistics released by the Michigan Employment Security Commission (MESC). As of December 31, 1977, 13,400 workers were employed in Michigan's mining industries (including metal mining, oil and gas extraction, and nonmetallic mining). The MESC listed an additional 300,300 workers in mineral-related industries, such as primary and fabricated metals and chemicals and petroleum.

An increase in mining fatalities took place in the State during 1977, as the Mine Safety and Health Administration reported six fatal accidents. One fatality occurred in the metal mining industry, while the remaining five took place in nonmetallic mining operations. Complete data regarding employment and injury statistics for mining in Michigan are given in table 4.

Michigan's copper miners continued to receive assistance under the Trade Readjustment Assistance Act of 1974. White Pine Copper Co. was certified for assistance in 1976. Sales and production of copper have continued to drop due to increased foreign imports.

At the close of 1977, the U.S. Department of Labor launched an investigation to determine whether 300 workers at Great Lakes Steel Co. in Wayne County are eligible for assistance under the Trade Readjustment Act. A petition for such assistance was filed in December, claiming layoffs resulted from the impact of imported steel on U.S. markets.

Table 4.—Michigan: Employment and injury statistics in the mineral industry in 1977[p]

	Employees	Employee-hours worked	Number of injuries			Frequency injury rates per million employee-hours[1]		
			Fatal	Nonfatal disabling	Non-disabling	Fatal	Nonfatal disabling	Non-disabling
Metal:								
Copper	1,315	1,673,499	--	43	25	--	25.69	14.94
Iron	4,606	7,599,262	1	197	21	.13	25.92	2.76
Total or rate-metal[2]	5,921	9,272,761	1	240	46	.11	25.88	4.96
Nonmetal:								
Cement	1,243	2,717,492	--	65	2	--	23.92	.74
Clays	130	255,046	--	1	--	--	3.92	--
Gypsum	204	499,583	--	15	9	--	30.03	18.02
Lime	96	192,246	--	1	4	--	5.20	20.81
Salt	216	439,211	--	15	38	--	34.15	86.52
Sand and gravel	2,049	2,859,896	3	46	41	1.05	16.08	14.34
Stone	1,858	3,536,959	2	54	2	.57	15.27	.57
Other nonmetals	203	394,237	--	--	--	--	--	--
Total or rate-nonmetal[2]	6,002	10,894,670	5	197	96	.46	18.08	8.81
Total or rate[2]	11,290	20,167,431	6	437	142	.30	21.67	7.04

[p] Preliminary.

[1] All injuries and all employee-hours reported and in file will be tabulated, but when computing injury-frequency rates, only those injuries for which employee-hours are reported and in file will be used.

[2] Data may not add to totals shown because of independent rounding.

Source: Health and Accident Analysis Center, Mine Safety and Health Administration, U.S. Department of Labor, Denver, Colo.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Nonmetallic mineral production continued its upward trend for the second consecutive year. The climb reflected continued improvement in the performance of the construction industry where many of the materials, notably gypsum, sand and gravel, and cement, are used. Nonmetals accounted for $640.5 million, or 39% of the State's total mineral value in 1977. Michigan remained a major producer of construction materials, natural salines, lime, salt, and peat.

Abrasives, Manufactured.—For the second year in a row, Michigan remained first in the national ranking of metallic abrasive producers. Production and value during the year decreased by 5% and 8%, respectively. Metallic abrasives were manufactured by three companies during the year: Abrasive Materials, Inc., at its Hillsdale plant; Cleveland Metal Abrasives Co., in Howell; and Ervin Industries, Inc., in Adrian.

Bromine.—Michigan ranked second in production and value of bromine in the United States during 1977. Output of elemental bromine decreased 23% in quantity and 31% in value compared with 1976 levels. Bromine was recovered from well brines in Michigan by three companies at four locations. Production of bromine compounds decreased 24%.

Velsicol Chemical Corp. (formerly Michigan Chemical Co.) faces a September 1978 deadline to cease operations in Gratiot County because of pollution violations. At the heart of the matter is a National Pollutant Discharge Elimination System Permit, revoked by the State of Michigan as part of a voluntary consent agreement signed by the company. The agreement called for shutdown of the plant by September 1978 if pollution requirements were not met. If the company continues to operate after the deadline, fines for not meeting current standards—which could total $500 to $1,000 per day since July 1, 1977—would have to be paid. Velsicol employs approximately 300 workers, with an annual payroll of about $2.6 million. Although the company has not produced raw bromine at this location for several years, bromine compounds are manufactured from raw bromine shipped to the Michigan facility from Arkansas.

The Dow Chemical Co. of Midland has signed a 10-year technical cooperative agreement with the Soviet Union, calling for the exchange of information and ideas, but which does not involve the sale of any Dow manufacturing technology. Dow reported that the two parties are negotiating the increased sale of petroleum products and agricultural chemicals.[7]

Calcium Chloride.—Three companies at four locations accounted for Michigan's total production of calcium chloride during 1977. Production and value showed substantial increases of 10% and 37%, respectively, when compared with 1976 figures. Michigan producers were The Dow Chemical Co. (Midland and Mason Counties); Velsicol Chemical Corp., formerly Michigan Chemical Co. (Gratiot County); and Wilkinson Chemical Corp. (Lapeer County).

The Dow Chemical Co., Michigan's largest producer of natural calcium chloride, announced plans for the construction of a new plant in Ludington that should be completed late in 1978. The plant will include production of calcium chloride pellets.

Cement.—Portland cement production rose 9%, while masonry cement increased 16% when compared with 1976 data. After the severe declines experienced in shipments during 1974-75, 1976 marked the initial and partial upturn point in the recovery of the cement industry. In 1977, industry shipments continued to maintain the recovery position, an impressive accomplishment considering the severe weather conditions of the early winter months that had to be overcome.

The cement industry's stress in announced programs has been on modernization rather than new construction due to the rise in construction costs. The average construction cost per ton of annual capacity is now over $100, more than double that of 10 years ago. Canada is also taking an increasingly larger role in supplying cement to the United States.

In March, Lake Ontario Cement, Ltd., purchased the Essexville cement plant belonging to Martin Marietta Cement Corp. for about $7 million. The price included property, plant, equipment, and current assets. A new subsidiary, the Aetna Cement Corp., was formed to operate the grinding facility and market the cement. Lake Ontario has been supplying the plant with clinker since April 1976 under a contract due to expire in 1979. The purchase will provide a substantial, well-established market bordering Ontario, Canada, and will assure Lake Ontario of continued high utilization of their clinker output after the contract period expires.

Table 5.—Michigan: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	8	7
Production	5,117,999	5,568,494
Shipments from mills:		
Quantity	4,931,392	5,582,391
Value	$145,381,014	$166,802,599
Stocks at mills, Dec. 31	688,745	513,797

Table 6.—Michigan: Masonry cement salient statistics

(Short tons)

	1976	1977
Number of active plants	5	5
Production	213,491	247,482
Shipments from mills:		
Quantity	217,799	246,343
Value	$8,369,742	$9,761,161
Stocks at mills, Dec. 31	72,120	71,264

At the close of 1977, Medusa Corp. announced a proposed merger with Oglebay Norton Co. Oglebay Norton is primarily engaged in mining, sale, and transportation of iron ore, coal, and other raw materials. The proposed combination is subject to the negotiation and execution of a satisfactory agreement between the two firms.

Meanwhile, Medusa has approved the expenditure of $50 million for the modernization of its Charlevoix facility. The project will involve the conversion of the existing kiln from a wet process to a dry process using flash calciner-preheater technology. It is part of Medusa's overall program to meet DOE's goal of reducing fuel consumption by 1982. Estimates indicate that conversion will result in approximately 33% fuel reduction per ton of cement produced. New dust collection equipment to be installed as part of the project will improve air quality in the area and will cost in excess of $5 million. Construction is scheduled for completion in the spring of 1980. Cement from the Charlevoix plant is presently sold in Michigan, Ohio, Indiana, Illinois, and Wisconsin. The new process, according to company officials, will enable

Medusa to compete more effectively with other cement companies in this region, particularly Canadian firms that are making inroads into the Midwest market.

A recently completed major modernization project at National Gypsum Co.'s Cement Div. plant in Alpena, together with improvements to the quarry equipment, is expected to be operational in 1978. The company has predicted that the project will reduce operating costs at the facility.

Clays.—Clays and shales were produced at nine locations during 1977, with the largest operations being located in Alpena, Antrim, Emmet, Monroe, and Wayne Counties. Approximately 92.5% of the clay produced in Michigan was used in the manufacture of cement. The remaining clay and shale was used in manufacturing face brick, flue lining, pottery, sewer pipe, and drain tile. Clay production and value rose 4% and 8%, respectively, reflecting the improvement in the cement and construction industries.

Michigan Brick & Tile Co. began a threefold expansion program at its Corunna (Shiawassee County) plant in 1977. Estimated cost of the project is $3.5 million. The project reportedly will increase production capacity for the plant by about 50%. The first phase of the expansion was the completion of a new crushing and grinding facility for raw material. The second major construction phase involved building a completely new and automated brick manufacturing plant. Scheduled date of completion for this phase is January 1978. The third construction phase was building a new manufacturing plant for a specialty brick product. The firm was purchased in 1976 by Janick Corp. of Toronto, Ontario, Canada.

Table 7.—Michigan: Common clay and shale sold or used by producers

Year	Number of mines	Quantity (short tons)	Value
1973	11	2,150,706	$3,304,398
1974	11	2,160,928	4,073,629
1975	11	1,818,102	3,579,774
1976	9	1,934,334	4,741,192
1977	9	2,007,391	5,125,835

Gypsum.—Michigan led the Nation in the production of crude gypsum in 1977, accounting for approximately 14% of the national total. The gypsum industry was able to capitalize on all phases of the strong recovery of the construction industry during the year. The high level of housing starts, an improvement in commercial building and other construction activity, as well as continued strength in the remodeling and consumer markets, helped to raise output of crude gypsum by 5% and calcined gypsum by 16%. National Gypsum Co.'s Tawas mine and United States Gypsum Co.'s Alabaster mine, both located in Iosco County, ranked second and third, respectively, in the order of total output for individual mines in the United States.

One use for gypsum is the production of gypsum board used by the construction industry. During the year, United States Gypsum Co. continued work on an expansion project at its Detroit plant to increase gypsum board productive capacity. No completion date has been announced for the project.

Table 8.—Michigan: Gypsum production and value

(Thousand short tons and thousand dollars)

Year	Production		Value	
	Crude	Calcined	Crude	Calcined
1973	1,882	596	8,538	11,677
1974	1,482	443	7,258	8,629
1975	1,224	385	5,936	9,689
1976	1,837	456	9,842	13,924
1977	1,924	529	8,778	13,087

Iodine.—Rebounding from a soft market in recent years, demand for iodine rose sharply during 1977. However, the initial operations of a second U.S. producer removed The Dow Chemical Co. of Midland from its traditional role of leading producer. Iodine at the Midland facility is produced as a byproduct of the brine operation. Production in 1977 decreased 39%, reflecting a decline in the production of other natural salines at the plant.

Lime.—Michigan remained a leading producer of lime in 1977, placing fifth among the States. Despite a generally improved economy, lime production decreased 7% during the year. Value rose 6%, reflecting continued inflationary pressures. The decrease in production was largely due to a slowdown in the iron and steel industry, a major consumer of lime, caused by a worldwide overavailability and import competition. Another area of reduced demand in Michigan was the beet sugar industry. During the past 2 years, increased imports of foreign sugar, both raw and refined, at prices reported to be below the cost of production, have had a serious impact on the viability of the domestic industry. This decrease in consumption affected lime production, since Michigan Sugar Co. produces lime for use in the sugar processing cycle. Other chemical uses and stabilization of the market helped to offset these lowered requirements. Lime is used in steel furnaces, alkalies, water treatment, and sugar refining.

Detroit Lime Co. reported a 1,000-ton-per-day expansion program for its operation in Detroit. The new system will include a Polygon preheater, rotary kiln, and contact cooler, all fired with pulverized coal. Completion is scheduled for January 1979.

Magnesium Compounds.—Statistics reported for 1977 indicate a slight rise in both production and value of magnesium compounds in Michigan. During the year, the State maintained its position as a leading producer of such compounds. A 3% increase in production and 7% rise in value reflected the shift by several companies to specialty products.

The slump in domestic steel production, traditional marketplace for about 80% of Martin Marietta Chemical Co.'s magnesium refractories, was offset by specialty refractory products sold in greater volume and new highs achieved in production and sale of magnesia chemicals. In March, the Refractories Div. began production of intermediate-grade magnesite at its Midland plant. Production capacity at the plant is projected at over 60,000 tons annually. The facility employs 35 persons. Startup of the plant, which was purchased from Kaiser Aluminum & Chemical Corp. in 1974, marks completion of a 4-year, $40 million expansion program.

This additional capacity permitted conversion of some facilities at Martin Marietta's Manistee plant to the production of chemical magnesia products that are in heavy demand by manufacturers of electrical heating elements, rubber, ceramics, paper, and building material. The Manistee plant was previously used for magnesite refractories. Switching kilns at Manistee to the production of chemical-grade magnesium oxide has increased annual capacity to 80,000 tons. In addition, production capacity of high purity periclase was tripled at the plant.

Oxygen.—Ford Motor Co.'s Powerhouse and Utility Operations operates an oxygen plant that is capable of producing approximately 650 tons of gaseous oxygen and 30 tons of liquid oxygen per day. Approximately 90% of the gaseous production is used in the steelmaking activities of the company's Rouge complex in Wayne County.

Peat.—Michigan remained the Nation's leading peat producer, accounting for approximately 27% of the U.S. total in 1977. Peat production, however, continued to decline due to increased competition from other States. While production dropped 19%, value rose about 15% compared with 1976 figures. Michigan peat is used primarily for soil improvement and as an ingredient in potting soils.

A proposed peat operation in St. Joseph County was temporarily postponed in 1977 as local residents protested the operation. They feared a lowering of the water table in the area and wanted to preserve the wetlands. The Michigan Environmental Review Board was requested to decide if an environmental impact study was needed for the 180-acre site. A National Pollution Discharge permit was issued by the Michigan Water Resources Commission early in the year, but Milburne Peat Co. of La Porte, Ind., did not exercise their options under the permit before the deadline expired. No decision regarding the future of the bog had been reached at yearend.

Perlite.—Energy costs and the severe winter weather of 1977 have spotlighted the value of insulation, and perlite producers stand to benefit. Most perlite finds its way into insulation, either directly or indirectly through other products. Horticultural uses of perlite are also making gains based on the increased interest in home gardening. Crude perlite, mined in other States, is expanded by Harborlite Corp. and U.S. Gypsum Co. at Michigan locations.

Phosphate Rock.—Potentially important deposits of rocks rich in the phosphate mineral apatite, a major raw material in fertilizer production, were found in northern Michigan by U.S. Geological Survey scientists. According to a published report, the newly discovered deposits are about 2 billion years old. The richest samples analyzed contained 40% to 60% apatite and about 15% phosphate, which is possibly of minable grade. Mining and processing in Michigan could result in cost savings to the midwestern farm belt in the form of lower transportation charges.

Salt.—Michigan was in fourth place nationally among salt producers for 1977. Production for the year amounted to 3,939,000 tons valued at $78 million, a decrease of 7% in output and 1% in value. Salt is produced by three methods in Michigan. These methods are as follows, in descending order of tonnages produced: (1) solution mining, (2) underground dry mining, and (3) extraction from natural brines.

All three producers of evaporated salt in Michigan completed major modernization and expansion projects during the year. Morton Salt Co., a division of Morton-Norwich Corp., completed a $2.8 million expansion and modernization project at its Manistee facility in September. Evaporated salt produced at Morton's two Michigan operations is used for table salt, food processing, high-quality chemical uses, and water softening. Diamond Crystal Salt Co., located at St. Clair, completed a $2.5 million program at its refinery in December 1977. Addition of a new evaporator increased capacity at that plant by one-third. Hardy Salt Co. met its 1977 completion deadline for a modernization program at Manistee.

Sand and Gravel.—Sand and gravel is a common mineral commodity in Michigan. Left behind by receding glacial action and the erosive forces of wind and water, this material is found in all of the State's 83 counties. In its natural state, sand and gravel is usually loose, easily handled, and readily compacted while retaining good internal drainage characteristics, making it a preferred and stable material for fill and as a base for pavement and other structures. When combined with a portland cement binder, it becomes the principal ingredient in concrete. When combined with asphalt, sand and gravel becomes the aggregate forming the major element of asphaltic concrete, widely used as a paving material. While some other materials may also be used as aggregate, sand and gravel is most commonly used for these purposes. As a natural deposit, it becomes a valuable resource when it is close to locations where aggregates may be needed for a broad range of uses. It's significance to the construction industry is illustrated by the national annual consumption of sand and gravel of about 5 tons per capita.[8]

Production of sand and gravel in Michigan during 1977 dropped 2% while value increased 29% when compared with 1976 figures. Actual figures for sand and gravel were 46,486,000 short tons, with a value of $101.5 million. Michigan ranked fifth in the production of sand and gravel in the United States, preceded by California, Alaska, Texas, and Ohio.

Table 9.—Michigan: Construction sand and gravel[1] sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1977	
	Quantity	Value[2]
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	12,979	26,847
Concrete products (cement blocks, bricks, pipe, etc.)	2,808	6,386
Asphaltic concrete aggregates and other bituminous mixtures	5,670	9,306
Roadbase and coverings	13,482	23,520
Fill	4,785	5,427
Railroad ballast	35	110
Other uses	615	1,000
Total	40,374	[3]72,595

[1] Includes processed and unprocessed sand and gravel.
[2] Values f.o.b. plant of blended processed sand and gravel used as construction aggregate.
[3] Data do not add to total shown because of independent rounding.

Table 10.—Michigan: Sand and gravel sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1977	
	Quantity	Value
Alcona	41	46
Alger	22	50
Allegan	488	951
Alpena	100	100
Antrim	92	173
Arenac	56	92
Baraga	163	271
Barry	445	903
Bay	W	W
Benzie	36	45
Berrien	1,290	7,050
Branch	W	W
Calhoun	435	959
Cass	606	1,082
Charlevoix	170	277
Cheboygan	W	W
Chippewa	572	989
Clare	290	436
Clinton	1,128	1,867
Crawford	49	73
Delta	323	597
Dickinson	212	499
Eaton	548	891
Emmet	171	282
Genesee	W	W
Gladwin	10	15
Gogebic	166	242
Grand Traverse	177	258
Gratiot	446	640
Hillsdale	462	882
Houghton	214	337
Huron	73	122
Ingham	891	1,267
Ionia	131	195
Iosco	3	5
Iron	244	439
Isabella	605	1,018
Jackson	324	576
Kalamazoo	809	2,169
Kalkaska	6	6
Kent	2,241	4,259
Lake	44	75
Lapeer	573	1,039
Leelanau	149	W
Lenawee	634	1,149
Livingston	1,872	3,113
Luce	45	120
Mackinac	159	270
Macomb	1,270	2,499
Manistee	154	217
Marquette	865	1,682
Mason	W	W
Mecosta	327	492
Menominee	84	118
Missaukee	180	248
Montcalm	361	1,004
Muskegon	691	3,211
Newaygo	W	W
Oakland	10,643	20,169
Oceana	522	2,808
Ogemaw	265	380
Ontonagon	187	225
Osceola	313	530
Otsego	25	38
Ottawa	1,871	5,138
Presque Isle	566	1,340
Saginaw	797	2,328
St. Clair	W	W
St. Joseph	429	825
Sanilac	385	577
Schoolcraft	58	81
Shiawassee	357	525
Tuscola	705	1,527
Van Buren	W	W
Washtenaw	2,057	3,319
Wayne	1,161	5,470
Wexford	608	1,660
Undistributed[1]	4,089	9,301
Total[2]	46,486	101,542

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes data withheld and some sand and gravel that cannot be assigned to specific counties.

[2] Data may not add to totals shown because of independent rounding.

American Aggregates Corp. began construction of a new aggregate plant at Galesburg (Kalamazoo County) in June. Trial production runs started at the end of the year. The plant has an annual capacity of 650,000 tons of sand and gravel. The Galesburg facility will replace the company's former Kalamazoo plant, where aggregate reserves have been depleted.

Within Michigan, industrial sand is mined from several sources for a variety of uses. The major source is the coastal sand dunes located along the western shore of the Lower Peninsula and along some of the Great Lakes shoreland in the Upper Peninsula. The sand found within these dune formations exhibits unique characteristics including consistency of grain size as a result of natural wind sorting. Inland dunes in Tuscola and Saginaw Counties and glacial sand deposits in Wexford County offer substantial sand reserves. These reserves, however, require more processing due to grain size, shape, and added impurities, and increased transportation costs due to their locations. Sand reserves found in Saginaw Bay prove to be more expensive to mine because special dredging techniques must be used. Major consumers of industrial sand produced in Michigan were foundries, glass manufacturers, and other miscellaneous industries that include such activities as chemical and metallurgical processing, abrasives, locomotion traction, and filters.

Development of a new industrial-quality sand deposit in St. Clair County began in August. Strauchman Industries began production on a 200-acre site under a contract with Ford Motor Co. for foundry sand to be used in the manufacture of crankshafts. The company, working with State agencies, has designed a reclamation plan including development of the pit as a recreation area when mining operations cease.

Table 11.—Michigan: Industrial sand and gravel sold or used by producers, by major use category

(Thousand short tons and thousand dollars)

Use	1977	
	Quantity	Value
Molding	4,495	21,200
Glass	454	2,908
Engine	24	110
Blast	3	17
Other uses[1]	1,136	4,712
Total	[2]6,113	28,947

[1] Includes sand and gravel used for grinding and polishing, foundry, filtration, and other uses.
[2] Data do not add to total shown because of independent rounding.

Sodium Compounds.—BASF-Wyandotte Corp. remained one of only three operating synthetic soda ash plants in the United States in 1977. The company, however, reported that operation problems in soda ash production reduced sales during the year.

Stone.—Five companies quarried dimension stone for rough construction stone, cut stone, rubble, and other uses during the year. Output increased 6% to 8,015 tons valued at $147,100. Leading producers were Jude Sandstone Co., Napoleon Sandstone Quarry, and Onaway Stone Co. Crushed stone was produced by 32 companies for lime, flux stone, cement, construction aggregate, and other uses. Output decreased to 40.5 million tons valued at $85 million. Leading producers were United States Steel Corp., Presque Isle Corp., and National Gypsum Co. Michigan ranked fifth in the Nation in production of marl. Tables 12 and 13 provide detailed information on the type of stone quarried and its uses in 1977 compared with 1976 data.

Inland Lime and Stone Co., a wholly owned subsidiary of Inland Steel Co., supplied 100% of the parent company's limestone and dolomite requirements in 1977 from the company's two Michigan quarries. This compares with supplying 98% of the stone in 1976.

The United States Steel Corp. agreed to spend $200,000 to restore Swan Lake near Rogers City (Presque Isle County). The company's quarrying operation at that location was cited by the State for discharging limestone tailings into the lake for over 20 years. Under terms of the agreement reached between United States Steel and the Michigan DNR, the company will

Table 12.—Michigan: Stone sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Kind	1976		1977	
	Quantity	Value	Quantity	Value
Dimension stone total[1]	8	129	8	147
Crushed and broken:				
Limestone and dolomite	40,214	77,296	39,489	80,725
Marl	66	156	22	67
Sandstone	W	W	W	W
Traprock	W	W	W	W
Other[2]	1,197	4,751	1,005	4,179
Total[3]	41,477	82,202	40,517	84,971
Grand total	41,485	82,331	40,525	85,118

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1] Includes limestone, dolomite, and sandstone.
[2] Includes sandstone and traprock.
[3] Data may not add to totals shown because of independent rounding.

Table 13.—Michigan: Crushed stone,[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Lime manufacture[2]	11,120	20,700	10,630	21,810
Flux stone	10,380	21,570	9,422	21,490
Cement manufacture	8,272	14,900	8,314	15,160
Concrete aggregate	4,531	7,643	4,444	8,248
Roadstone	1,223	1,844	2,540	5,273
Bituminous aggregate	954	1,864	1,231	2,480
Dense-graded roadbase stone	829	1,779	1,126	2,547
Macadam aggregate	1,934	4,275	W	W
Agricultural limestone	510	1,142	430	923
Riprap and jetty stone	375	730	370	722
Railroad ballast	309	542	266	583
Surface treatment aggregate	119	280	125	304
Soil conditioner	66	156	22	67
Other uses[3]	858	4,775	1,600	5,410
Total[4]	41,477	82,202	40,517	84,971

W Withheld to avoid disclosing company proprietary data; included with "Other uses."
[1] Includes limestone, sandstone, marl, and traprock.
[2] Includes stone used in chemical stone for alkali works, sugar refining, and dead-burned dolomite (1977).
[3] Includes stone used for refractory stone, glass manufacturing, mineral food, paper manufacturing, filter stone, terrazzo and exposed aggregate, and uses indicated by symbol W.
[4] Data may not add to totals shown because of independent rounding.

dredge 50,000 cubic yards of tailings from the lake and make other improvements. In return for cleaning the lake, the DNR has agreed to extend the company's water discharge permit from a July 1, 1977, deadline to January 1, 1978. At that time, the firm must cease discharge of tailings into the lake.

Sandstone is currently mined by two producers in Jackson County for use as rough dimensional stone and by one producer in Wayne County who turns out industrial sand for use in glassmaking and as foundry sands. The Wayne County deposit contains high silica, uncontaminated sand grains that are suited for use in glassmaking.

Marl, a nonconsolidated calcium carbonate-rich material deposited in a lake or marsh area, is produced by five operators located in Allegan, Barry, Branch, and St. Joseph Counties. Marl is used as a soil conditioner in Michigan.

Sulfur.—Increases of 20% in production and 10% in value were reported for byproduct sulfur in 1977. Total Petroleum (N.A.) Ltd., and Marathon Oil Corp. continued to produce this commodity at their refineries in Gratiot and Wayne Counties, respectively. During 1977, work continued at Shell Oil Co.'s $6 million plant in Manistee County for separation of sulfur from natural gas. The sulfur conversion plant is necessary to meet environmental requirements and will allow Shell to produce and sell the sulfur as a byproduct. As construction work continued, a tentative completion date was set for 1978, with an expectation to go onstream in November.

Vermiculite.—The growing emphasis on home and building insulation in the latter part of 1977 led to an increase in consumption of exfoliated vermiculite. Michigan imports crude vermiculite from other States for processing at W. R. Grace & Co.'s plant in the Detroit area.

MINERAL FUELS

Mineral fuels (natural gas, natural gas liquids, and petroleum) were valued at $567.7 million, or 35% of the total mineral value. According to the American Petroleum Institute, proved Michigan reserves of crude oil declined in 1977. As of December 31, 1977, reserves stood at 133,228,000 barrels, down some 5,560,000 barrels from the 1976 figure. Michigan production during the year totaled about 33 million barrels of crude oil and natural gas condensate.

According to the American Gas Institute, natural gas proved reserves in Michigan at the end of 1977 totaled about 1,791,200 million cubic feet, an increase of 193,054 million cubic feet above from estimates for the previous year. Production of natural gas amounted to about 130,000 million cubic feet during the year.

METALS

Metallic minerals represented $414.4 million, or 26% of the total raw mineral value in 1977. The decline in iron ore shipments was attributed to a 113-day strike against the CCI, while reduced copper output reflected the continued depressed copper market. A continued decrease in silver production, a byproduct of the copper industry in Michigan, followed copper's example.

Copper.—Michigan accounted for about 3% of the national copper output in 1977. Production came from the State's only operating copper mine which dates back to 1865, when the White Pine orebody was discovered. Copper was first mined between 1879 and 1881. The property was later sold to Calumet and Hecla Mining Co., who spent $2 million in exploration and development. Before World War I, the copper could be produced for less than 13 cents per pound and sold for more than 25 cents per pound. The company employed 300 men at that time. Following a dip in copper prices after the war, the mine and much of the town development halted. Copper Range Co. acquired the property at a sheriff's sale in 1929.

Years of testing and research followed. With the advent of the Korean War, the Federal Government requested that Copper Range attempt to develop the orebody. The company established its operations in 1952, producing the first copper in 1955.

Since 1975, White Pine Copper Co., a Copper Range subsidiary, has been forced into periodic layoffs. Market conditions, combined with foreign imports, have crippled the U.S. copper industry. According to company reports, White Pine mine loses money each day it operates and the company is making every effort to minimize the loss while staying in operation. As of December 31, 1977, White Pine employed 1,297 persons, down about 1,800 employees from the peak employment of over 3,000 workers in 1974. The firm tried unsuccessfully to merge with AMAX Inc., in 1975, but a Federal judge blocked the proposal.

In May 1977, shareholders of Copper Range Co. voted to merge with the Louisiana Land & Exploration Co (L&E). The merger, which took effect immediately, included the White Pine mine/mill/smelter complex in Ontonagon County and also extensive mineral rights in that area. The complex produced 42.2 million pounds of refined copper from May through December and shipments for the same period totaled 33.6 million pounds, at an average price of 66 cents per pound.[9] Late in 1977, LL&E began a systematic appraisal of the exploration potential of its nearly 500,000 acres of mineral rights.

Homestake Copper Mining Co., an active producer in 1976, conducted exploration work in Michigan's Upper Peninsula during the year. However, the depressed copper market forced the company to halt operations by yearend and officials indicated that further work would be abandoned.

During 1976, Quincy Mining Co. and Homestake Copper Mining Co. combined efforts to explore the feasibility of reopening the Quincy mine at Ripley. In January 1977, the Quincy No. 8 shaft was reactivated and underground drilling of a cross section on the 10th level was started. The 10th level is approximately 1,380 feet deep on the incline. Quincy has contributed about $360,000 of the $425,000 advance pledged to the joint venture.

Table 14.—Michigan: Mine production (recoverable) of silver and copper

		1975	1976	1977
Mines producing: Lode		2	2	1
Material sold or treated: Copper ore	thousand short tons	9,033	3,801	3,510
Production:				
Quantity:				
Silver	troy ounces	632,336	310,837	335,479
Copper	short tons	73,690	43,707	42,375
Value:				
Silver	thousands	$2,795	$1,352	$1,550
Copper	do	94,618	60,840	56,613
Total	do	97,413	62,192	58,163

Iron Ore.—Iron ore is produced at four open pit and two underground mines in Michigan. Producers are CCI at four locations in Marquette County, Inland Steel Co. in Iron County, and Hanna Mining Co. in Dickinson County. According to statistics gathered by the Geological Survey Div., Michigan DNR, iron ore production amounted to 12,463,132 long tons in 1977 compared with 17,023,658 long tons in 1976. Statistics relating to the iron ore industry are given in tables 15-17. The iron ore industry employed an average of 3,344 workers during the year.

Production at the CCI operations in Michigan during 1977 declined when a strike by members of the United Steelworkers of America idled about 3,400 employees for 113 days. The strike was the first in the basic steel industry since 1959. Both union and management officials had signed the landmark Experimental Negotiating Agreement in 1973, which banned nationwide strikes in favor of binding arbitration of unresolved issues. CCI facilities affected by the walkout included the Empire, Mather B, Tilden, and Republic mines and the Humboldt and Pioneer Ore Improvement Plants. Over 10% of the Marquette area workers draw their paychecks from CCI, and the company payroll exceeded $90 million in 1977. The strike began on August 1 and was settled on November 21, 1977.

Employees at the Groveland mine, owned and operated by Hanna Mining Co., ratified a new 3-year contract without a work stoppage during the year. The Groveland produced about 2.1 million tons of pellets in 1977, an increase of 5% over the 1976 output.[10]

CCI has secured nearly $900 million in financing for expansion of its Tilden and Empire mining projects in Marquette County and the Upper Peninsula Generating Co. at Presque Isle. The Tilden expansion is expected to begin operations in mid-1979, while the Empire project is scheduled for startup in early 1980. The Tilden project will add approximately 1,000 new employees to the current mine operation and is expected to provide an additional $17.5 million in wages annually.

While expansion and growth is taking

Table 15.—Michigan: Iron ore produced and shipped in 1977, by range and mine

(Long tons)

Range and mine	Production	Shipments
Marquette:		
Empire	3,752,031	3,958,622
Mather B	1,194,071	71,866
Pioneer Pellet plant[1]	--	751,663
Republic-Humboldt	2,425,642	2,115,136
Tilden	2,603,157	2,786,116
Total Marquette range	9,974,901	9,683,403
Menominee:		
Groveland	2,120,284	2,117,066
Sherwood	367,947	215,239
Total Menominee range	2,488,231	2,332,305
Grand total	12,463,132	12,015,708

[1] Includes 998,872 tons of pellets produced from Mather ore.

Source: Reed, R. C., and H. O. Sorensen. General Statistics Covering Production of Michigan Iron Mines. Geological Survey Div., Michigan Department of Natural Resources, 1977.

Table 16.—Michigan: Usable iron ore[1] produced (direct-shipping and all forms of concentrates), by range

(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total		
				Gross weight		
				Ore[2]	Iron content	Iron content (percent)
1854-1972	408,724	297,883	249,625	956,232	NA	NA
1973	9,036	2,404	--	11,440	7,210	63.02
1974	8,920	2,419	--	11,339	7,153	63.08
1975	12,443	2,331	--	14,774	9,327	63.1
1976	14,663	2,318	--	16,980	10,759	63.4
1977	W	W	--	12,319	7,798	63.3
Total[2]	W	W	[3]249,625	1,023,084	NA	NA

NA Not available. W Withheld to avoid disclosing company proprietary data.

[1] Exclusive after 1905 of iron ore containing 5% or more manganese.

[2] Data may not add to totals shown because of independent rounding.

[3] Distribution by range partly estimated before 1906.

Table 17.—Michigan: Iron ore shipped from mines

(Thousand long tons)

Year	Direct-shipping ore[1]	Concentrates and agglomerates, total	Total usable ore[2]	Proportion of beneficiated ore to total usable ore (percent)
1973	463	11,927	12,389	96.3
1974	548	11,054	11,602	95.3
1975	288	13,801	14,089	98.0
1976	356	15,888	16,245	97.8
1977	W	W	12,009	W

W Withheld to avoid disclosing company proprietary data.

[1] Includes crushed, screened, and sized ore not further treated.

[2] Data do not add to total shown because of independent rounding.

place at CCI operations which utilize new and improved processing techniques, Inland Steel Co. announced plans for the gradual phasing out of operations at its Sherwood underground mine in Iron River. Mining will continue at the current rate until mid-1978, while shipments during this period will decrease. The extra ore will be stockpiled until the storage area at the mine is full. Shipments will continue through the 1981 shipping season. The ore produced at the Sherwood is a high-phosphorus (3.5%), non-Bessemer, direct-shipping ore. Modern steelmaking techniques cannot effectively use the ore to produce high-quality steel. The mine has been producing about 400,000 tons per year, and will have produced and shipped about 14 million tons when operations cease in 1981. The Sherwood is the last remaining operating mine in Iron County on the Menominee range. Inland Steel shipped 212,767 long tons of coarse and fine ore from the Sherwood mine in 1977.[11]

Published prices for Lake Superior iron ore rose about 5% in 1977. Freight rates for most lake and rail routes also increased between 8% and 11%.[12]

Iron Oxide Pigments.—Shipments of crude iron oxide pigments from CCI in Marquette County dropped substantially during 1977. The decrease in production and shipments is attributed to the 113-day work stoppage at the company's mining operations. Red pigments produced by CCI are used for automobile undercoating, railroad cars, structural steel, animal feed and fertilizer, and foundry sand.

Finished iron oxide pigments (red and yellow) were notable contributors to profits at BASF-Wyandotte Corp. during 1977. Their new plant, which began production in 1976, captured a good share of the automotive paint market during its first full year of production. The plant is located at the company's complex in Wyandotte.

Iron and Steel Scrap.—North Star Steel Co. ended a 3-year period of speculation by announcing at the end of 1977 that it will build a $70 million steel mill in Monroe. Construction on the 400,000-ton-per-year capacity plant is scheduled to begin in 1978 on a 195-acre site owned by the Monroe Port Authority near Lake Erie. The plant, which will use electric furnaces to recycle scrap metal into steel products for use in the automotive and related industries, should be operational in January 1980. The plant's initial work force of 450 employees should grow to about 900 within 5 years, and its capacity will eventually be increased to about 1.5 million tons per year.[13]

The partners in Hoover-Ugine Co. are still undecided about the fate of the innovative rod-making facility that closed in December 1976 because of technical problems. The Bridgman plant was designed to manufacture rod and wire products from scrap without remelting. The process used at Hoover-Ugine was developed by Battelle Memorial Institute. It involved compacting cleaned and shredded scrap steel into billets that were then heated but not melted. The process ran into trouble because of the inconsistency of the scrap steel that was used.

The Grand Haven Brass Foundry announced plans early in 1977 for a $1 million expansion project at its plant in Grand Haven. The project includes renovation of an existing building and replacement of obsolete melting equipment and dust collection systems.

Hayes-Albion Corp. of Jackson announced plans for a 5-year, $10.8 million expansion program for its Albion casting plant. The expansion is expected to increase the annual capacity of the facility by 22,000 tons (total of 122,000 tons) and will enable the firm to produce castings of nodular iron as well as the malleable iron castings now being produced. The program will be in two stages, with expansion of the molding facilities scheduled for completion by July 1978. Conversion to the nodular iron production is scheduled for completion during fiscal 1980. The new production line, which will replace one of the plant's automated molding lines, will permit an easier and quicker change of patterns and the capability of producing a broader variety of castings. The Hayes-Albion Corp. is the Nation's second largest independent producer of malleable castings and is a leading manufacturer of die castings.

Chevrolet Motor Div. of General Motors Corp. began the addition of a multimillion dollar casting line to its nodular iron casting plant at Saginaw in 1977. The expansion is expected to be operational in the fall of 1979, and will add an estimated 400 to 500 new jobs in the area. The new line will include complete molding, melting, finishing, and shipping facilities. The plant already has five such complete lines. Nodular iron is used to make many major automotive parts.

Pig Iron and Steel.—Michigan ranked fourth among iron and steel producers in

1977, preceded by Pennsylvania, Indiana, and Ohio. These four States accounted for approximately 67% of the total iron and steel production for the year.

McLouth Steel Corp. experienced a 10-day work stoppage by some 4,000 steelworkers in October 1977. Members of two United Steelworkers of America locals struck McLouth, the Nation's 11th largest steel producer, after a 3-year contract expired on October 1. Work resumed on October 11 when an agreement was reached.

Among other steelmakers, modernization and conversion programs were initiated during the year. The Chevrolet Saginaw grey iron casting plant began a conversion project that will eventually create about 100 new jobs. Conversion is scheduled for completion in 1978. The conversion project required increasing the size and capacity of two existing cupolas, revisions to the existing molding line, changes in the finishing department, and changes in cupola emission control systems to handle the increase in size and capacity. The Grey Iron Plant employs about 6,000 workers and is reported to be the largest grey iron foundry in the world. Grey iron is used in the automotive industry for cylinder blocks and heads, where its ability to absorb vibration is advantageous. Since its beginning in 1919, the Saginaw plant has produced more than 28 million tons of iron for use in Chevrolet trucks and cars.

General Motors Corp. announced a multimillion dollar modernization project at its Pontiac Motor Div., but no completion date was set. The Pontiac foundry employs about 2,000 hourly and more than 200 salaried persons.

Kurdziel Iron Industries, located in Oceana County, began an expansion program that will increase annual production to 20,000 tons of castings. With the proposed expansion, the plant will employ 120 persons when operating at full capacity. Current employment of the plant is 70 persons, with an average production of 12,000 to 13,000 tons of castings annually.

A private inventor was awarded a $99,600 grant from DOE to carry on a project that might save steelmakers 200 million pounds of aluminum per year, that is about equal to $100 million. The concept is being tested by McLouth Steel Corp. in Trenton. The key to the project is finding how to measure molten steel's temperature and oxygen content. That information would make it possible to calculate precisely the amount of aluminum needed. Considering all the elements involved in steelmaking, the inventor claims that enough energy would be saved to equal that generated by two nuclear powerplants operating for 1 year.

Silver.—White Pine Copper Co., which became part of LL&E in 1977, continued to recover silver from copper ore mined in Ontonagon County. Statistics regarding production and value are included in table 14.

Slag-Iron and Steel.—Edward C. Levy Co., located in Wayne County, continued to process slag from the Ford Motor Co.'s Steel Div. Great Lakes Steel Co., and McLouth Steel Corp. during the year. Michigan remained one of the Nation's leading processors of slag, categorized as a manufactured mineral commodity and used by the construction industry.

Uranium.—In September 1974, a uranium exploration agreement was entered into by TVA, American Copper & Nickel Co. (a subsidiary of INCO Ltd.), and David S. Robertson and Associates Inc., to identify and explore areas within the Continental United States that have a favorable potential for the discovery of economically recoverable uranium deposits. During 1977, the work was limited to the Upper Peninsula of Michigan. The program in the State included core drilling, trenching, and field surveys on about 200,000 acres leased from Ford Motor Co.

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[1] State Liaison Officer, Bureau of Mines, Lansing, Mich.

[2] Liaison program assistant, Bureau of Mines Liaison Office, Lansing, Mich.

[3] Cannon, W. F. Summary of the Estimated Iron Resources of the Marquette and Gogebic Iron Ranges of Michigan. U.S. Geological Survey, Open File Rept. 78-153, 1978.

[4] Skillings' Mining Review. V. 66, No. 4, Jan. 22, 1977, p. 26.

[5] Bennett, G. H., and J. D. Herrich. Evaluation of Resin and Mechanical Roof Bolting Systems for Strata-Bound Deposits (Research Contract No. H0230016). BuMines Open File Rept. 31-77, 1974, 109 pp.; available for consultation at Bureau of Mines facilities in Denver, Colo., Twin Cities, Minn., Bruceton and Pittsburgh, Pa., and Spokane, Wash.; U.S. Department of Energy facility in Morgantown, W. Va.; National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.; and National Technical Information Service, Springfield, Va., PB 264062/AS.

[6] LABORegister. V. 1, No. 4, September 1977, p. 93.

[7] Michigan Manufacturer and Financial Record. "On Michigans's Industrial Front." V. 141, No. 2, February 1978, P. 28.

[8] Schellie, K. L. (ed. by). Sand and Gravel Operations - A Traditional Land Use. National Sand and Gravel Association, Silver Spring, Md., 1977, p. 1.

[9] Louisiana Land & Exploration Co. Annual Report 1977.

[10] Hanna Mining Co. Annual Report 1977, p. 6.

[11] Skillings' Mining Review. V. 67, No. 6, Feb. 11, 1978, p. 17.

[12] Skillings' Mining Review. V. 67, No. 6, Feb. 11, 1978, p. 17.

[13] Michigan Manufacturer and Financial Record. V. 141, No. 5, May 1978, p. 10.

Table 18.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Amcord, Inc., Peerless Cement Div.[1]	9333 Dearborn St. Detroit, MI 48209	Quarry and plant ----	Wayne.
Dundee Cement Co--------	Box 317 Dundee, MI 48131	----do ----------	Monroe.
Medusa Cement Co., a division of Medusa Corp.	Box 5668 Cleveland, OH 44101	----do ----------	Charlevoix.
Cement Division, National Gypsum Co. [2]	17515 West Nine Mile Rd. Southfield, MI 48075	----do ----------	Alpena.
Penn-Dixie Industries, Inc.	Box 152 Nazareth, PA 18061	----do ----------	Emmet.
Clay and shale:			
Michigan Brick & Tile Co----	3820 Serr Rd. Corunna, MI 48817	Pit and plant -------	Shiawassee.
Copper: White Pine Copper Co.[3] --	Box 427 White Pine, MI 49971	Underground mine and plant.	Ontonagon.
Gypsum:			
Michigan Gypsum Co ------	2840 Bay Rd. Saginaw, MI 48601	Open pit mine and plant	Iosco.
National Gypsum Co ------	325 Delaware Ave. Buffalo, NY 14202	----do ----------	Do.
United States Gypsum Co----	101 South Wacker Dr. Chicago IL 60606	Open pit mine ------ Plant ------------	Do. Wayne.
Iron ore:			
Cleveland-Cliffs Iron Co.[4] ----	504 Spruce St. Ishpeming, MI 49849	3 open pit mines, 1 underground mine, and plants.	Marquette.
Hanna Mining Co --------	Star Route 1, Box 131 Iron Mountain, MI 49801	Open pit mine and plant	Dickinson.
Iron and steel:			
Ford Motor Co ----------	The American Rd. Dearborn, MI 48121	Plant ------------	Wayne.
McLouth Steel Corp -------	300 South Livernois Ave. Detroit, MI 48217	----do ----------	Do.
National Steel Corp -------	2800 Grant Bldg. Pittsburgh, PA 15219	----do ----------	Do.
Lime:			
BASF Wyandotte Corp -----	1609 Biddle Ave. Wyandotte, MI 48192	Limekiln----------	Do.
Detroit Lime Co ---------	8800 Dix Ave. Detroit, MI 48209	----do ----------	Do.
Marblehead Lime Co., a division of General Dynamics.	300 West Washington Chicago, IL 60606	----do ----------	Do.
The Dow Chemical Co., Ludington Div.	2020 Dow Center Midland, MI 48640	----do ----------	Mason.
Natural salines:			
Martin Marietta Chemicals Refractories Div.[5]	Executive Plaza II Hunt Valley, MD 21030	Brine wells and plant --	Manistee.
Morton Chemical Co.[5] ------	110 North Wacker Dr. Chicago, IL 60606	----do ----------	Do.
The Dow Chemical Co.[5] -----	2020 Dow Center Midland, MI 48640	----do ----------	Mason and Midland.
Peat:			
Al-Par Peat ------------	9551 Krouse Ovid, MI 48866	Bog and plant-------	Shiawassee.
Anderson Peat Co --------	332 Graham Rd. Imlay City, MI 48444	----do ----------	Lapeer.
Michigan Peat, Inc--------	Box 66388 Houston, TX 77006	Bogs and plants------	Sanilac.
Salt:			
BASF-Wyandotte Corp -----	1609 Biddle Ave. Wyandotte, MI 48192	Brine wells and plant --	Wayne.
Diamond Crystal Salt Co ----	916 South Riverside Dr. St. Clair, MI 48079	----do ----------	St. Clair.
International Salt Co., Inc ---	12841 Saunders St. Detroit, MI 48217	Underground mine ---	Wayne.
Sand and gravel (construction):			
American Aggregates Corp---	Drawer 160 Greenville, OH 45331	Surface pits and stationary plants.	Kalamazoo, Livingston, Macomb, Oakland.
Grand Rapids Gravel Co ----	2700 28th St., SW. Grand Rapids, MI 49509	----do ----------	Kent.
Holly Sand and Gravel Co., Aggregates Div. of J. P. Burroughs & Son, Inc.	Box 1468 Saginaw, MI 48605	Surface pit, stationary and portable plants.	Oakland.
Medusa Aggregates Inc., Western Materials Div.	4200 South Milford Rd., Box H New Hudson, MI 48165	Surface pit and stationary plant.	Do.

See footnotes at end of table.

Table 18.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (industrial):			
Manley Bros. of Indiana, Inc	Box 67 Chesterton, IN 46304	Surface pit and plant	Berrien.
Nugent Sand Co., Inc	Box 566, 2875 Lincoln Muskegon, MI 49443	do	Muskegon.
Ottawa Silica Co	33620 Streicher Rd. Rockwood, MI 48173	do	Wayne.
Sargent Sand Co	2840 Bay Rd. Saginaw, MI 48605	do	Mason, Saginaw, Tuscola, Wexford.
Slag iron and steel:			
Edward C. Levy Co	8800 Dix Ave. Detroit, MI 48209	Plant	Wayne.
Stone:			
Limestone:			
Drummond Dolomite Inc., a division of Bethlehem Steel Corp.	701 East Third St. Bethlehem, PA 18016	Quarry and plant	Chippewa.
Inland Lime and Stone Co., a division of Inland Steel Co.	Gulliver, MI 49840	do	Mackinac and Schoolcraft.
Limestone Operations, United States Steel Corp.	Rogers City, MI 49779	Quarry	Mackinac and Presque Isle.
Presque Isle Corp	Box 426 Alpena, MI 49704	do	Presque Isle.
Wallace Stone Co., a division of J.P. Burroughs & Son, Inc.	Box 1468 Saginaw, MI 48605	do	Huron.
Marl: Brenner, Kevin D	Route 1 Hopkins, MI 49328	Pit	Allegan.
Sandstone:			
Jude Stone Quarry Co	338 Austin Rd. Napoleon, MI 49261	Quarry	Jackson.
Napoleon Sandstone Quarry	Box 119 Napoleon, MI 49261	do	Do.
Ottawa Silica Co., Michigan Silica Div.	33620 Streicher Rd. Rockwood, MI 48173	Quarry and plant	Wayne.

[1] Also produces clay or shale.
[2] Also produces stone.
[3] Also produces silver.
[4] Also produces iron oxide pigments.
[5] Includes bromine, bromine compounds, calcium compounds, iodine, and magnesium compounds.

The Mineral Industry of Minnesota

By Ronald C. Briggs[1] and Wanda J. West[2]

During 1977, the value of Minnesota's mineral production declined by more than 28% to $875.6 million, reversing a 5-year trend of consecutive and record-setting increases. The sharp decrease in total value was largely attributed to the loss of iron ore shipments created by the longest strike in the history of the iron ore industry in Minnesota. The supply of sand and gravel for the construction industry also declined more than 9%; however, an increase in unit prices raised the 1977 total value to nearly 22% over that for the previous year.

The 138-day steelworkers' strike in the iron ore industry closed all but three natural ore mines and resulted in a 37% decrease in iron ore shipments. The 30.2 million long tons shipped from Minnesota mines was still sufficient to retain the State's leadership in iron ore production, accounting for about 56% of the total domestic iron ore production. The demand for a uniformly sized and higher grade iron ore by the steel mills was evidenced by the fact that taconite pellets from eight operations accounted for a record 85% of the iron ore produced in the State. The depletion of high-grade natural ore reserves in Minnesota also resulted in taconite pellets accounting for a greater share of iron ore shipments. For the first time in the 94-year history of Minnesota's iron ore industry, no direct-shipping grade ore was produced. All iron ore, including both natural ore and taconite, was produced from 33 open pit mines in the northern part of the State.

Table 1.—Mineral production in Minnesota[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons--	W	W	[2]163	[2]$276
Gem stones ----------------------	NA	$15	NA	15
Iron ore (usable) thousand long tons, gross weight--	47,874	1,137,733	30,245	782,627
Lime ---------- thousand short tons--	103	2,794	123	4,815
Manganiferous ore---------short tons--	202,271	W	166,440	W
Peat ---------- thousand short tons--	26	1,505	28	1,280
Sand and gravel ---------------do----	[3]33,486	[3]44,503	30,713	59,629
Stone--------------------do----	7,567	25,767	7,865	25,124
Combined value of abrasive stone, clays (common 1976, and kaolin), industrial sand (1976), and values indicated by symbol W --	XX	5,713	XX	2,337
Total----------------------	XX	1,218,030	XX	875,603
Total 1967 constant dollars --------	XX	625,215	XX	[p]432,198

[p] Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes kaolin; value included in "Combined value" figure.

[3] Excludes industrial sand; value included in "Combined value" figure.

Coupled with the decrease in value for metals, the combined value of nonmetallics rose in the percentage distribution and accounted for more than 10% of the State's total mineral production value. The combined value total for nonmetallics represented an increase of over 16% from that for 1976. Sand and gravel and stone accounted for the greatest share of the nonmetallic value, and these commodities ranked second and third, respectively, in both quantity and value of all commodities produced in the State. The percentage changes in quantity and value for sand and gravel were diametrically opposite when comparing 1977 data with that for the previous year. The quantity decreased more than 9% while the value showed a significant rise of 22%. Most other nonmetallic minerals showed increases in both quantity and value with the exception of peat and stone, but the percentage variations were not nearly as great as those for sand and gravel.

Of the 87 counties in the State, only 5 reported no mineral production during 1977. Sand and gravel was produced in each of the 82 mineral-producing counties and stone in 24. St. Louis and Itasca Counties ranked first and second, respectively, in value of mineral production because of the large number of iron ore mines in these two areas. In addition to the top ranking counties, 20 other counties recorded mineral production valued in excess of $1 million.

Although other firms were engaged in exploration activities, AMAX Exploration, Inc., continued to be the copper-nickel-mining pioneer in the State. The current phase of the Minnamax project near Babbitt was to determine the continuity of the mineralization indicated by surface diamond drilling. To date, more than 500,000 feet of core drilling has been completed on this project. AMAX completed a 1,720-foot exploration shaft in June and by yearend completed 3,780 feet of horizontal drifts from this shaft. Underground diamond drilling will be performed at the Minnamax project to verify the results of surface drilling. A total of 63,000 tons of mineralized material was removed from the underground drifts and will be used for testing and research purposes.

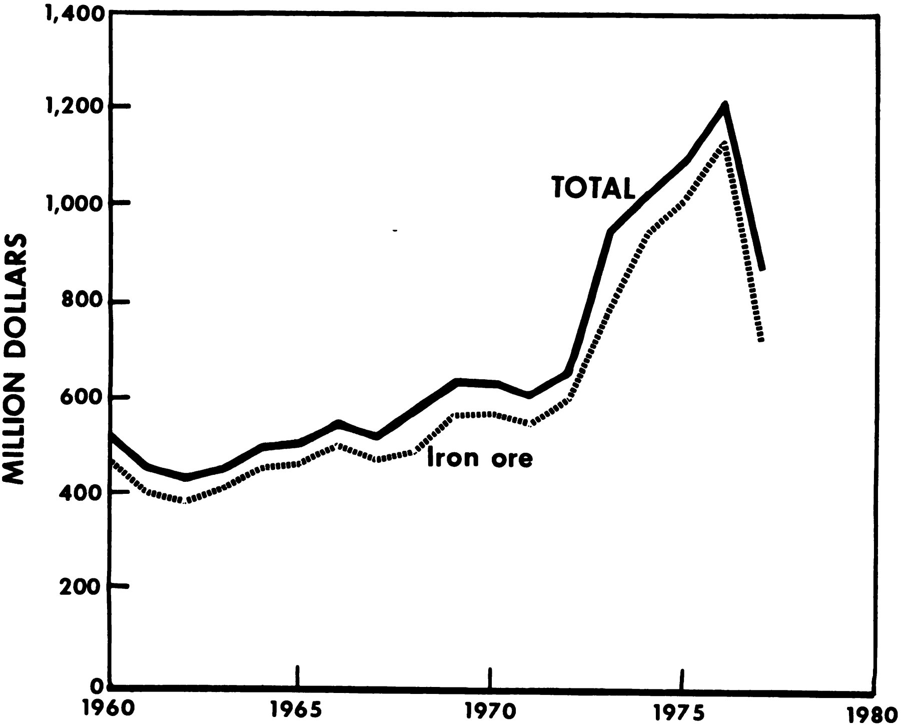

Figure 1.—Value of iron ore shipments and total value of mineral production in Minnesota.

Table 2.—Value of mineral production in Minnesota, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Aitkin	W	W	Peat, sand and gravel.
Anoka	W	W	Sand and gravel.
Becker	$433	$479	Do.
Beltrami	852	523	Do.
Benton	53	--	
Big Stone	W	W	Stone, sand and gravel.
Blue Earth	W	W	Do.
Brown	W	W	Sand and gravel, clays.
Carlton	W	W	Peat, sand and gravel.
Carver	W	W	Sand and gravel.
Cass	581	465	Do.
Chippewa	371	495	Do.
Chisago	207	345	Do.
Clay	3,175	3,906	Sand and gravel, lime.
Clearwater	308	237	Sand and gravel.
Cook	W	216	Do.
Cottonwood	243	230	Do.
Crow Wing	W	W	Manganiferous ore, sand and gravel.
Dakota	W	5,048	Sand and gravel, stone.
Dodge	W	W	Stone, sand and gravel.
Douglas	318	450	Sand and gravel.
Faribault	W	W	Do.
Fillmore	1,231	1,098	Stone, sand and gravel.
Freeborn	753	965	Sand and gravel.
Goodhue	368	558	Sand and gravel, stone.
Grant	W	5	Sand and gravel.
Hennepin	W	W	Sand and gravel, clays.
Houston	W	W	Stone, sand and gravel.
Hubbard	184	340	Sand and gravel.
Isanti	76	--	
Itasca	130,165	99,468	Iron ore, sand and gravel, peat.
Kanabec	179	258	Sand and gravel.
Kandiyohi	899	1,215	Do.
Kittson	315	551	Do.
Koochiching	225	418	Do.
Lac qui Parle	W	W	Stone, sand and gravel.
Lake	W	312	Sand and gravel.
Lake of the Woods	56	78	Do.
Le Sueur	W	W	Sand and gravel, stone.
Lincoln	W	11	Sand and gravel.
Lyon	W	75	Do.
McLeod	73	85	Do.
Mahnomen	W	80	Do.
Marshall	W	260	Do.
Martin	60	8	Do.
Meeker	162	248	Do.
Mille Lacs	W	W	Stone, sand and gravel.
Morrison	552	2,098	Sand and gravel.
Mower	W	W	Stone, sand and gravel.
Murray	10	63	Sand and gravel.
Nicollet	W	W	Stone, sand and gravel.
Nobles	W	W	Sand and gravel.
Norman	W	291	Do.
Olmsted	1,966	2,602	Stone, sand and gravel.
Otter Tail	682	411	Sand and gravel.
Pennington	W	205	Do.
Pine	365	W	Do.
Pipestone	W	--	
Polk	1,904	2,920	Lime, sand and gravel.
Pope	96	131	Sand and gravel.
Ramsey	W	W	Do.
Red Lake	61	5	Do.
Redwood	W	W	Sand and gravel, clays, stone.
Renville	W	W	Lime, stone, sand and gravel.
Rice	W	3,201	Sand and gravel, stone.
Rock	W	W	Sand and gravel, abrasives, stone.
Roseau	W	5	Sand and gravel.
St. Louis	W	W	Iron ore, cement, sand and gravel, peat, stone.
Scott	2,661	2,814	Stone, sand and gravel.
Sherburne	1,578	1,687	Sand and gravel.
Sibley	W	82	Do.
Stearns	W	W	Stone, sand and gravel.
Steele	1,051	W	Sand and gravel, stone.
Stevens	W	W	Sand and gravel.
Swift	64	146	Do.
Todd	709	564	Do.
Wabasha	494	669	Stone, sand and gravel.
Wadena	18	W	Sand and gravel.
Waseca	W	150	Do.
Washington	6,265	7,890	Sand and gravel, stone.
Watonwan	W	142	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Minnesota, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Wilkin	$109	$171	Sand and gravel.
Winona	W	2,149	Stone, sand and gravel.
Wright	511	774	Sand and gravel.
Yellow Medicine	1,096	1,104	Stone, sand and gravel.
Undistributed[2]	1,056,559	726,907	
Total[3]	1,218,030	875,603	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Jackson and Traverse Counties were not listed because no production was reported.

[2] Includes some sand and gravel that cannot be assigned to specific counties, value of gem stones, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Minnesota business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ... thousands	1,859.0	1,918.0	+3.2
Unemployment ... do	110.0	98.0	-10.9
Employment (nonagricultural):			
Mining ... do	14.9	12.0	-19.5
Manufacturing ... do	321.6	338.4	+5.2
Contract construction ... do	65.4	69.5	+6.3
Transportation and public utilities ... do	89.9	92.9	+3.3
Wholesale and retail trade ... do	383.5	404.9	+5.6
Finance, insurance, real estate ... do	77.9	82.5	+5.9
Services ... do	291.5	311.5	+6.9
Government ... do	276.0	284.7	+3.1
Total nonagricultural employment ... do	1,520.7	1,596.4	+5.0
Personal income:			
Total ... millions	$24,666	$28,337	+14.9
Per capita	$6,237	$7,129	+14.3
Construction activity:			
Number of private and public residential units authorized	26,973	38,337	+42.1
Value of nonresidential construction ... millions	$303.7	$433.4	+42.7
Value of State road contract awards ... do	$128.0	$145.0	+13.3
Shipments of portland and masonry cement to and within the State ... thousand short tons	1,601	1,714	+7.1
Mineral production value:			
Total crude mineral value ... millions	$1,218.0	$875.6	-28.1
Value per capita, resident population	$307	$220	-28.3
Value per square mile	$14,489	$10,415	-28.1

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Mineral exploration activity, particularly for base metals and uranium, has intensified in Minnesota. A project conducted by the Minerals Division of the Minnesota Department of Natural Resources (DNR) produced indications of zinc deposits on State land along the Rainy River in northwestern Koochiching County. The study only indicated the presence of zinc and not an economic ore body. Exploration for uranium has been underway in Carlton and Pine Counties. The Rocky Mountain Energy Co. is doing some exploratory drilling as part of a nationwide program by the firm to find marketable deposits of uranium material.

Employment and Injuries.—According to statistics published by the Minnesota Department of Economic Security, employment in the mining and quarrying industries at yearend 1977 totaled 12,600, more than 12% less than at the end of 1976. The decrease in employment reflected the fact that the iron ore mining industry, accounting for a large percentage of employees, had not called back all workers by yearend after a 138-day strike that ended in mid-December.

Legislation and Government Programs.—An omnibus tax bill (Chapter 423) passed during the 1977 Legislative Session contained several provisions affecting taconite mining. The bill included the following mineral-related provisions: 1. It increased the taconite production tax from 80 cents per ton to $1.25 per ton effective January 1, 1977. The tax will automatically increase depending on the price of finished steel and the iron content of the taconite. The tax will be calculated on a 3-year average or on the current year of production, whichever is larger. The three former production taxes were repealed and replaced with this one higher tax. 2. The maximum property tax that is assessed on unmined taconite when less than 1,000 tons of iron ore concentrate is removed from a 40-acre tract in any 1 year was increased from $1 to $10 an acre. 3. It imposed a new tax of 10 cents per ton on taconite companies that do not dispose of their tailings on land in accordance with State permits after July 1, 1977. 4. Owners or lessees of mineral rights who have engaged in exploration for, or mining of, taconites or iron sulfides are now required to file with the Commissioner of Revenue a variety of information regarding the location, nature, quality, or quantity of the unmined ores. The measure also made changes in the distribution of the taconite tax collections and the dates on which the tax is payable.

Gravel produced in Kittson and Marshall Counties is subject to an occupation tax of not to exceed 10 cents per cubic yard under terms of Chapter 112 enacted during 1977. The tax does not apply to the State or its contractors, however, when the gravel is used in construction and maintenance of trunk highways. Ninety percent of the gravel revenues will go to the county road and bridge fund and the remaining 10% to the reserve fund for restoration of abandoned gravel pits. Chapter 117 of the 1977 Statutes imposes a similar tax of not to exceed 5 cents per cubic yard of gravel produced in Becker County.

The 1973 State Mineland Reclamation Act charged the Minnesota DNR with the responsibility of developing rules and regulations for the reclamation of currently active and future metal mining operations in Minnesota. In October, the DNR released a preliminary set of proposed rules for public review. The rules were to be revised based on the review comments received and were expected to go through public hearings in the fall of 1978.

REVIEW BY MINERAL COMMODITIES

METALS

Copper-Nickel.—At a site 4 miles south of Babbitt in St. Louis County, AMAX Exploration, Inc., was progressing on schedule at its Minnamax copper-nickel project. In the phase of the Minnamax project conducted during 1977, AMAX sought to determine the continuity of the mineralization indicated by surface diamond drilling and to determine the mining and environmental parameters. More than 500,000 feet of core drilling has been completed on the project site to date. AMAX, in cooperation with the State agencies, has been conducting extensive environmental and base-line studies. The exploration shaft which was begun in March 1976 was bottomed at a depth of 1,728 feet in June 1977. An underground station was completed at the 1,700-foot level, and 3,780 feet of horizontal drifts were completed from this test shaft. About 50,000 feet of drilling will be performed from these underground drifts in an effort to probe the mineralized area and to verify its continuity with interpretations from surface drilling. Late in 1977, the firm shipped a 1,300-ton bulk sample to the University of Minnesota and a 500-ton sample to the Federal Bureau of Mines Twin Cities Metallurgy Research Center for testing purposes. A 1,000-ton bulk sample of typical copper-nickel mineralization was scheduled for delivery to Lakefield Research of Canada, Ltd., of Lakefield, Ontario, to determine the concentrating characteristics. In all, a total of 63,000 tons of mineralized material was removed from the underground drifts. Although a combined open pit and underground operation is being proposed for the Minnamax project, it will be several years before any final mining decisions can be made. The decisions will not depend strictly upon the quantity of copper and nickel in the mineralized material because State decisions on environmental, social, and economic considerations and the value of copper and nickel in the world market will be important factors.

The Regional Copper-Nickel Study, organized by the Minnesota Environmental Quality Council, continued to collect information and data to analyze the impact that may result from potential copper-nickel development in the Duluth Complex. The area under study covers a large portion of northeastern Minnesota with attention focused along the most probable mining area covering 560 square miles along the Duluth Complex Contact in Lake and St. Louis Counties, stretching roughly from the Boundary Waters Canoe Area near Ely to

Hoyt Lakes. The study objective is to regionally characterize the area, then hypothetically produce stresses on the region due to mining activities, and finally, to assess potential impacts of these stresses on both the short- and long-term bases. The State will use this information to make decisions concerning the development of copper-nickel resources available in northeastern Minnesota. A final report will be submitted to the January 1979 Legislative Session for its consideration and review.

The Minnesota DNR published the findings of a study of the copper, nickel, and titanium resources of a portion of the Duluth Complex. This study was conducted to provide the Regional Copper-Nickel Study with basic mineral resource information. The results of this study indicate that the minesite area (560 square miles) under study contains about 4.4 billion tons of mineralized material with an average grade of 0.66% copper and 0.2% nickel. Lesser, but significant, quantities of silver, gold, platinum, palladium, and cobalt also exist.

Iron Ore.—The longest steelworkers' strike in the union's history brought the Minnesota iron ore industry to a virtual halt from August 1 until mid-December and resulted in a 37% decrease in iron ore shipments from those of the previous year. When the national contract of the United Steelworkers of America expired on August 1, a variety of issues raised by union locals led to an immediate work stoppage at all but three of Minnesota's iron ore mines. Only the natural iron ore mining operations of Cleveland-Cliffs Iron Co. and Jones & Laughlin Steel Corp. were not affected. About 14,500 steelworkers in northeastern Minnesota were idled by the strike, which was the first union-endorsed widespread strike in the steel industry since 1959. At issue were approximately 1,250 local differences ranging from seniority to job transfers, with the key issue of incentive pay common to all union locals.

On November 21, employees of the Hibbing Taconite Co. became the first of the striking workers to reach an agreement.

Table 4.—Minnesota: Iron ore[1] data in 1977, by county and range

(Thousand long tons)

County and range	Crude ore production[2]	Usable ore: Stocks Jan. 1	Usable ore: Production	Usable ore: Iron content of production	Usable ore: Shipments	Usable ore: Stocks Dec. 31
County:						
Itasca	14,041	368	4,211	2,540	4,491	87
St. Louis[3]	83,090	5,627	26,732	16,617	25,754	6,605
Total[4]	97,131	5,994	30,943	19,157	30,245	6,692
Mesabi Range	97,131	5,994	30,943	19,157	30,245	6,692

[1] Exclusive of ore containing 5% or more manganese.

[2] Entire production from open pit mines.

[3] Includes Lake County.

[4] Data may not add to totals shown because of independent rounding.

Table 5.—Minnesota: Production and shipments of usable iron ore[1]

(Thousand long tons)

Year	Production: Natural ore	Production: Taconite pellets	Production: Total[2]	Production: Iron content (percent)	Shipments: Natural ore	Shipments: Taconite pellets	Shipments: Total[2]	Shipments: Proportion of taconite pellets to total ore (percent)
1973	18,420	41,601	60,021	60.53	19,013	43,601	62,614	69.63
1974	17,541	40,944	58,484	60.02	18,282	41,140	59,422	69.23
1975	10,466	40,711	51,177	60.58	10,553	38,615	49,167	[r]78.54
1976	9,152	40,612	49,764	61.34	8,806	39,068	47,874	[r]81.61
1977	4,600	26,343	30,943	61.91	5,123	25,122	30,245	83.06

[r] Revised.

[1] Exclusive of ore containing 5% or more manganese.

[2] Data may not add to totals shown because of independent rounding.

Other union locals followed suit, and the 138-day-old strike ended on December 16 when Inland Steel Co. workers voted to accept a contract offer. The major change effected in contracts was the incorporation of incentive pay into wages, effective in 1979. The change will reportedly give workers as much as 75 cents per hour more than standard wage rates. Settlements at many locals concerned complex work assignments related to seniority, improvements in dust control, and a myriad of other concessions.

The lengthy strike had a ripple effect that resulted in a large number of layoffs in the service industries, retail trade, and government in iron range communities. Railroads transporting ore to the upper lake docks and the Great Lakes shipping fleets were affected almost immediately by the strike, as the inventories of iron ore stockpiled at shipping terminals were depleted. This resulted in the layoff of several hundred employees from those industries. Additional financial losses were reflected in the collection of State taxes. The Department of Revenue estimated the total loss in direct revenues as a result of the strike at $45 million. The estimate included losses from taconite production and occupation taxes paid by mining companies, gross earnings tax revenues on railroads, withholding taxes paid by striking steelworkers, and related levies. It did not, however, include losses from the State sales tax in the area.

The 30.2 million long tons of iron ore shipped from Minnesota mines, although a substantial decrease from the previous year, still accounted for 56% of the domestically produced iron ore and maintained the State's leadership in iron ore production. Taconite pellets from eight plants accounted for a record 85% of the usable iron ore produced in the State, raising the average iron content of the total production to 61.91%. Average iron content of the taconite pellets was 63.20%. The demand for high-quality ore—uniform in size, grade, and structure—and the depletion of the high-grade natural ore reserves have been evidenced by the continual decline of direct-shipping-grade ore produced in recent years. The 1977 season marked the first year in the 94-year history of Minnesota's iron ore industry in which no direct-shipping ore was produced. All taconite and natural ore was produced from 33 open pits—27 in St. Louis County and 7 in Itasca County. One mine, the National Steel pit near Keewatin, extends into both counties.

The $1.25 billion taconite expansion program that has been in progress on the Mesabi range for several years continued. The completion of two major projects was realized during the year, leaving the expansions of U.S. Steel's Minntac plant and the Hibbing Taconite plant the only construction projects that were incomplete at yearend.

The expanded facilities of National Steel Pellet Co. near Keewatin went on-stream early in 1977 following a 2 1/2-year construction period. Completed at a capital cost exceeding $150 million, the project more than doubled the annual pellet capacity of the 10-year-old plant, increasing it from 2.4 to 5.8 million tons. National Steel Pellet Co. is owned 85% by National Steel Corp. and 15% by The Hanna Mining Co.

Inland Steel Mining Co., a subsidiary of Inland Steel Co., produced the first pellets from its new $150 million Minorca facility at Virginia in May. Employment at Minorca was expected to total 450 persons with an annual payroll of about $7 million. Full production at the rated annual capacity of 2.6 million tons of pellets, anticipated in 1978, will provide one-third of the total iron ore requirements of the company's Indiana Harbor steelworks. The Minorca pellets will replace ore from Inland's Caland mine at Atikokan, Ontario, which will exhaust its economically recoverable reserves in 1979. Shipments from the plant will be by rail to the Duluth, Missabe & Iron Range Railway (DM&IR) dock facilities at Two Harbors, and thence by lake to Inland's blast furnaces.

The longest and most costly environmental proceedings in the history of the United States came nearer to an end during 1977, when on April 8 the Minnesota Supreme Court ruled unanimously in favor of Reserve Mining Co. and ordered the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources to issue permits for onland disposal of the firm's taconite tailings at Reserve's preferred Milepost 7 site. The permits will be subject to 12 stringent conditions demanded earlier by the State agencies and agreed to by Reserve and its two parent companies, Armco and Republic Steel Corporations. The conditions are designed to protect the environment and to mitigate the potential health threat from asbestiform fibers in the taconite. In all, about 200 permits from State agencies and the U.S. Army Corps of

Engineers will be required for construction and operation of the disposal facility. The granting of some of the permits remained a legal issue at yearend. Site preparation work for the tailings disposal project near Silver Bay began on June 1 and was expected to be completed in about 3 years. A Federal court judge extended the deadline by which Reserve must halt its discharge of taconite tailings into Lake Superior from July 7, 1977, to April 15, 1980. In addition to the disposal site, Reserve's $370 million construction project includes an air quality improvement program and modifications and additions to its plant facilities needed to end the lake discharge.

Lake Superior iron ore prices established early in 1977 remained in effect throughout the remainder of the year. The rates were as follows: Mesabi-non-Bessemer, $21.18 per ton (coarse, $21.98, and fine, $20.73); Old Range non-Bessemer, $21.43; and manganiferous, $21.43. The foregoing prices were for ore delivered at rail-of-vessel at lower Lake ports and were based on a natural iron content of 51.50%. The lower Lake price of pellets increased 4.5% in early January to 55.5 cents per long ton iron unit and remained at that level throughout 1977. The price rise was mainly to compensate for increased costs of energy and capital equipment. The average mine value for Minnesota iron ores was $25.88, compared with $23.77 in 1976.

According to rates published in mid-1977, the cost of transporting iron ore from the Mesabi range to lower Lake ports ranged from $7.75 to $7.94 per long ton. The rates include a dock handling charge of $0.44 at upper Lake docks but do not include handling charges at lower Lake ports.

Severe winter weather brought a halt to iron ore shipping on the Great Lakes in January, following a record 33 consecutive months of shipping. Vessels from the U.S. Steel fleet had sailed continuously from Two Harbors to lower Lake steel mills since April 9, 1974, whereas other Great Lakes ports had closed at the end of the 1974-75 and 1975-76 shipping seasons.

The 1977 navigation season for ports shipping Minnesota iron ore opened March 21 at Two Harbors and was underway at all ports by April 25. Dates of first and final cargo loadings at all ports shipping Minnesota iron ore are shown in table 6.

Table 6.—Dates of first and final cargoes of Minnesota iron ore shipped from upper Great Lakes ports

Port and dock	1976		1977	
	First	Final	First	Final
Duluth, Minn.: DM&IR	Apr. 11	Dec. 19	Apr. 6	Dec. 31
Silver Bay, Minn.: Reserve	Apr. 1	Jan. 1 [1]	Apr. 11	Feb. 1 [2]
Superior, Wis.: Burlington-Northern	Apr. 9	Dec. 26	Apr. 18	Jan. 14 [2]
Taconite Harbor, Minn.: Erie	Apr. 4	Dec. 28	Apr. 25	Jan. 27 [2]
Two Harbors, Minn.: DM&IR	([3])	Jan. 19 [1]	Mar. 21	([3])

[1] 1977.

[2] 1978.

[3] Vessel loadings at the DM&IR docks at Two Harbors continued without interruption during the 1975-76, 1976-77, and 1977-78 shipping seasons.

Construction activity continued throughout the year on the DM&IR pellet storage and shiploading facilities at Two Harbors in Lake County. Completion of the $35.5 million project is scheduled for mid-1978.

Shipbuilding activity and the trend toward larger vessels continued. In February, the Army Corps of Engineers increased the maximum length of vessels permitted to enter the largest lock (Poe) on the Soo Canal from 1,000 feet to 1,100 feet. No companies have yet announced plans, however, to construct vessels of greater length than 1,000 feet. Several new vessels of the 1,000-foot class are scheduled for completion during the next few years.

The newest of the 1,000-foot class is the *Mesabi Miner* of Pickands Mather & Co.'s (PM) Interlake Steamship Co. fleet, which was christened on June 11 in Duluth. Whereas ore carriers have traditionally been named after key executives in the mining and shipping industries, the new vessel was named as a tribute to the workers of the Mesabi iron range. The *Mesabi Miner* is 1,000 feet in length, has a beam of 105 feet, and has a cargo capacity of 59,000 gross tons of taconite pellets or 52,000 tons of coal. The self-unloading vessel is identical to PM's *James R. Barker*, which entered service in August 1976. These two vessels were the largest carriers built entirely on the Great Lakes. The American Ship Building Co. constructed the *Mesabi Miner* during a 2-year period at its Toledo and Lorain, Ohio, yards. Its initial cargo of 54,321 tons of pellets, from the recently opened Burlington-Northern facility in Allouez, Wis., represented one of the largest single cargoes ever handled at the Head of the Lakes. The *Mesabi Miner*'s unloading system is capable of discharging pellets at the rate of 10,000 tons of iron ore per hour.

The research program to evaluate the extensive nonmagnetic taconite deposits of the western Mesabi range as a source for steelmaking was continued by the Federal Bureau of Mines at its Twin Cities Metallurgy Research Center. The western Mesabi range contains approximately 10 billion tons of oxidized taconite materials assaying 30% to 40% iron, which have not previously been used as an iron ore source. These taconites are considered the best prospect for overcoming the deficiency between domestic requirements and production predicted for the end of the century, and the Bureau is investigating various technologies suitable for processing these materials economically. The Center also continued efforts to develop improved methods of pellet production.

Erie Mining Co.'s Hoyt Lakes plant was chosen by the Federal Energy Research and Development Administration (ERDA) as the site of a $39 million coal gasification demonstration project. Methane gas created by the plant from coal will be used by Erie Mining Co. (Pickands Mather & Co., operating agent) in its pelletizing plant. The plant will process about 500 tons of coal per day. ERDA will provide Erie with $4.5 million to do the design research and will ultimately provide $23 million of the total $39 million cost. A 5-year program is planned for the design, construction, and operation of the demonstration plant. Gas from the plant would ultimately replace the natural gas and fuel oil currently used to fire Erie's pellet furnaces.

The Iron Range Interpretative Center, administered by the Department of Iron Range Resources & Rehabilitation, opened during mid-1977, and in fulfilling its mission of telling the dynamic story of the development of the mining regions of northeastern Minnesota, immediately began attracting visitors from all over the United States. The Center is located near Chisholm on the brink of the abandoned Glen mine and has a 150-foot, glass-enclosed observation bridge which projects out over the mine. Through audiovisual presentations and imaginative displays and exhibits, the facility tells the story of the culture and history of the people of the iron range and interprets the iron mining industry and its role in the history of the area.

Iron and Steel.—North Star Steel Co. continued to produce steel from ferrous scrap at its two electric furnaces in St. Paul. In April, the company began production of forged alloy steel grinding balls at its new $4 million facility in Duluth, and by September the plant was in full production. The plant has an annual production capacity of 40,000 tons of 1- to 2-inch grinding balls. The extremely hard steel balls will be used primarily in Minnesota's taconite plants; however, they will also find use in pulverizing material in the cement, copper, and other industries. Special bar-quality steel is shipped to the Duluth plant from North Star's St. Paul plant and is converted into grinding balls on three forging machines. An electric induction heating process helps provide the hardness required in grinding balls. North Star Steel was considering expanding the Duluth plant to forge other products and was studying the market for railroad spikes.

Manganiferous Ore.—The Pittsburgh Pacific Co. produced manganiferous ore (containing 5% to 35% manganese) from the Algoma-Zeno mine and processed it at the Virginia concentrator at Ironton. Material was also recovered from the Hopkins lean ore stockpile. Total shipments decreased to 166,000 short tons, 18% less than in 1976.

Table 7.—Minnesota: Shipments of manganiferous ores[1] from the Cuyuna Range

	Ferruginous manganese ore (10% to 35% Mn, natural)		
		Contents (natural)	
	Shipments (long tons)	Fe (percent)	Mn (percent)
1973	152,563	27.69	12.59
1974	201,393	29.64	12.74
1975	97,097	30.83	11.84
1976	180,599	27.00	12.80
1977	148,607	29.17	13.39

[1] All manganiferous ores shipped from the Cuyuna Range in 1977 were ferruginous manganese ore containing 10% to 35% manganese. There have been no shipments of manganiferous iron ore containing 5% to 10% manganese since 1969.

Uranium.—Extensive exploration was underway in Minnesota during 1977 for uranium deposits to fuel the Nation's nuclear powerplants. Search for the radioactive element has been spurred by its projected shortage during the energy crunch and the high prices it brings on the open market. Carlton County and Pine County were identified as two of the "hot spots" where the Rocky Mountain Energy Co. began drilling in November to find marketable deposits of the scarce mineral. The drilling program followed preliminary exploration work by the company, including aerial surveys that have been conducted for the past 2 years. Rocky Mountain Energy Co., a wholly owned subsidiary of Union Pacific Corp., filed about 38 leases with Carlton County to cover test drilling on privately owned land.

The U.S. Department of Energy (DOE) has been conducting uranium investigations at several locations in Minnesota. The agency has flown widely spaced airborne radiometric surveys in northwestern Minnesota and intends to complete airborne surveys in west-central and southwestern Minnesota in the near future. The Minnesota Geological Survey and personnel from the University of Minnesota-Duluth have been working under contract to DOE to conduct several surveys. The Minnesota DNR has also been involved in a general survey for uranium in the Ely-Lake Vermilion area.

NONMETALS

Abrasive Stone.—Production of grinding pebbles and tubemill liners by Jasper Stone Co. in Rock County increased slightly over that of 1976. In operations spanning more than half a century, grinding media have been produced from a quartzite deposit at this location utilizing the hand craftmanship of stonecutters—a practice found to be superior to automated machines for quarrying and processing these products. The Jasper quarry is one of only two or three in the Nation whose extremely hard and close-grained rock is used to produce grinding media and mill lining blocks. The liner blocks are produced in four sizes, with dimensions of 5 by 8 to 10 inches, and thicknesses ranging from 2-1/2 to 5 inches. Grinding pebbles are also formed in four sizes, ranging from 1 by 2-1/2 inches to 4 by 5 inches. The products are shipped to nearly all of the 50 States and to several foreign countries and are used by industrial mineral processing plants for grinding materials such as feldspar, fertilizer, foundry sands, gypsum, paint pigments, silica flour, and ceramic and pottery materials.

Cement.—No cement was produced in the State during 1977. The Minnesota Pollution Control Agency conducted public hearings regarding a permit application filed by Intermix Corp. of White Pine, Mich., to reopen the Duluth cement plant formerly operated by Universal Atlas Cement Div. of United States Steel Corp. The proposed reopening plans were being contested by local residents because of environmental concerns. No ruling on the application had been issued at yearend.

Clays.—Common clay and shale was produced near Springfield in Brown County by Acolite, Inc., and Ochs Brick & Tile Co., and near Minneapolis in Hennepin County by Aglite, Inc. Ochs Brick & Tile Co. also produced kaolin in Redwood County. Concrete block and face brick manufacture constituted the greatest use of the clay, with lesser amounts used for structural concrete products and other uses.

The Marshall Economic Development Corp. continued its study of the potential of clay deposits along the Minnesota River, mainly in Redwood and Renville Counties.

Lime.—American Crystal Sugar Co. produced lime for use in its sugar refining operations at the following locations: Moorhead in Clay County, Crookston and East Grand Forks in Polk County, and Renville in Renville County. Despite a 12-day strike by employees in early September, production at each of the plants was greater than during the previous year. The total lime output increased 19% in quantity and 54% in value. Consumption of lime in Minnesota in 1977 from all U.S. sources was 262,887 tons. Out-of-State shipments came mainly from Wisconsin.

Peat.—Moss peat and reed-sedge peat were produced by four companies from bogs in Aitkin, Carlton, Itasca, and St. Louis Counties. Although the quantity of peat sold increased slightly, a decline in the average unit price resulted in a 15% decrease in the total sales value. Nearly 89% of the peat was sold in packaged form and the remainder in bulk. Uses included general soil improvement, mushroom beds, ingredient for potting soils, and other horticultural purposes.

Prior to 1977, the Bureau of Mines classified peat as a fuel. However, to more closely aline peat with the Standard Industrial Classification groupings—and because peat has traditionally been used for other-than-fuel purposes in the United States—the Bureau began classifying it as a nonmetal in mid-1977.

Minnesota, with 7.2 million acres of peatland, ranks second to Alaska (27 million acres) in total peatland acreage in the United States; most of these peatlands are now undeveloped. Great interest in the potential of Minnesota peat continued during the year with a variety of intense studies being conducted by State agencies and the Bureau of Mines.

The Bureau's Twin Cities Mining Research Center began work on a project to evaluate peat extraction methods and to develop first stage dewatering of large quantities of peat consistent with a concern for environmental quality. Preliminary dredging and dewatering experimentation took place at a northern Minnesota site on State-owned land in Koochiching County. Additional field tests and further evaluations are proposed for Minnesota peatlands.

The Minnesota DNR was studying the potentials and impacts of development of the 16.1 billion tons of peat in the State. Several management possibilities were being considered, including utilization for agriculture, forestry, horticulture, energy, chemical and industrial feedstocks, and recreation; preservation with no development; and combinations of these approaches.

The State has committed $1.25 million from 1976 through 1979 to inventory the resource, investigate suitable technologies for peat utilization, and study the natural and social environmental effects of development. In addition, the Upper Great Lakes Regional Commission (U.S. Department of Commerce) has granted $284,000 to Minnesota for preliminary impact studies and assessment of information needs on the peat issue. The goal of these investigations is to provide needed information to the Minnesota State Legislature for peatland management policy formulation.

The Department of Iron Range Resources & Rehabilitation (IRR&R) continued peat studies at its Wilderness Valley Farms facility near Zim, the site of extensive peat research by the Department since it acquired the property in 1964. Activities during 1977 included peat-drying experiments initiated in 1976, hydrology studies, land reclamation experiments, testing tree growth patterns in the bog, and experiments in agriculture and horticulture.

Basic research by Minnesota Gas Co. (Minnegasco) regarding the feasibility of converting peat to pipeline-quality synthetic natural gas continued. Company plans call for the construction of a demonstration plant in northern Minnesota by 1983 that would be capable of producing 80 million cubic feet of synthetic gas per day. The second phase of Minnegasco's peat project would be a full-scale gasification plant with a daily capacity of 250 million cubic feet. None of the required Environmental Impact Statements had been approved at yearend, nor had the company's 1975 application for the lease of 200,000 acres of State-owned peatland been acted upon. Action on that application and on the applications of horticultural peat companies for about 25,000 acres of State-owned land is being delayed until the State develops policy and regulations for peat.

Sand and Gravel.—Sand and gravel maintained its role as the second leading mineral commodity produced in Minnesota. Although total production (including industrial sand) dropped to 30.7 million tons, the value of sales increased to $59.6 million, comprising 7% of the total value of all minerals produced in the State during 1977. Output was reported by 354 companies from 415 locations in 82 of the State's 87 counties. No production was reported from Benton,

Table 8.—Minnesota: Sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976 Quantity	1976 Value	1977 Quantity	1977 Value
Construction sand and gravel:				
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	7,511	14,073	9,577	20,722
Concrete products (cement blocks, bricks, pipe, etc.)	3,151	5,863	2,977	6,666
Asphaltic concrete aggregates and other bituminous mixtures	6,855	8,489	4,861	8,402
Roadbase and coverings	10,637	11,589	8,710	14,289
Fill	4,278	3,496	3,418	3,497
Railroad ballast	--	--	15	24
Other uses	1,054	992	473	696
Total[1]	33,486	44,503	30,030	54,297
Industrial sand	W	W	683	5,332
Grand total	W	W	30,713	59,629
All uses of construction sand and gravel:				
Sand	12,676	12,461	9,883	16,196
Gravel	20,810	32,041	20,147	38,101

W Withheld to avoid disclosing company proprietary data.

[1] Data may not add to totals shown because of independent rounding.

Table 9.—Minnesota: Sand and gravel sold or used by producers, by county[1]

(Thousand short tons and thousand dollars)

County	1976[2]			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Aitkin	3	49	61	4	49	72
Anoka	1	311	W	2	W	W
Becker	8	407	433	7	266	479
Beltrami	7	599	852	6	213	523
Benton	1	55	53	--	--	--
Brown	3	119	189	3	243	461
Carlton	3	198	109	8	313	456
Cass	6	271	581	7	270	465
Chippewa	5	445	371	5	286	495
Chisago	4	169	207	3	137	345
Clay	10	1,795	2,655	12	1,593	3,156
Clearwater	5	343	308	4	158	237
Cook	2	W	W	2	139	216
Cottonwood	5	188	243	4	165	230
Crow Wing	11	232	243	12	353	712
Dakota	r16	2,389	3,138	13	2,510	4,323
Dodge	1	33	16	1	10	15
Douglas	r6	228	318	7	213	450
Fillmore	4	64	113	3	42	75
Freeborn	10	523	753	9	498	965
Goodhue	6	198	235	7	218	351
Grant	2	W	W	1	3	5
Hennepin	22	3,583	3,812	20	3,263	5,312
Hubbard	5	148	184	5	195	340
Isanti	1	28	76	--	--	--
Itasca	7	589	1,410	10	1,050	2,134
Kanabec	3	116	179	3	127	258
Kandiyohi	5	660	899	5	700	1,215
Kittson	3	201	315	3	302	551
Koochiching	7	258	225	9	270	418
Lake	2	W	W	3	216	312
Lake of the Woods	1	50	56	1	52	78
Le Sueur	2	W	W	5	1,161	3,881
Lincoln	2	W	W	1	7	11
Lyon	2	W	W	1	50	75
McLeod	3	64	73	4	57	85
Mahnomen	2	W	W	2	53	80
Marshall	2	W	W	4	136	260
Martin	1	50	60	1	5	8
Meeker	3	74	162	3	154	248
Mille Lacs	3	102	123	6	248	397
Morrison	4	232	552	6	•912	2,098
Mower	3	117	144	3	76	143
Murray	2	18	10	2	42	63
Nicollet	2	W	W	3	288	534

See footnotes at end of table.

Table 9.—Minnesota: Sand and gravel sold or used by producers, by county[1] —Continued

(Thousand short tons and thousand dollars)

County	1976[2]			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Norman	2	W	W	3	226	291
Olmsted	4	396	514	4	490	871
Otter Tail	6	443	682	7	263	411
Pennington	2	W	W	2	115	205
Pine	3	466	365	2	W	W
Polk	5	490	569	7	434	725
Pope	3	64	96	3	67	131
Red Lake	1	114	61	1	3	5
Redwood	5	367	338	5	317	469
Renville	4	318	394	3	420	651
Rice	7	258	343	7	554	3,201
Roseau	2	W	W	1	3	5
St. Louis	33	2,448	3,390	46	1,764	3,183
Scott	4	518	533	4	405	628
Sherburne	10	991	1,578	9	945	1,687
Sibley	1	W	W	3	55	82
Stearns	7	638	590	6	220	405
Steele	7	550	773	6	406	732
Swift	1	126	64	1	97	146
Todd	7	772	709	7	349	564
Wabasha	3	128	207	3	179	287
Wadena	1	19	18	2	W	W
Waseca	2	W	W	1	100	150
Washington	19	W	W	20	2,866	6,249
Watonwan	4	W	W	4	64	142
Wilkin	4	133	109	3	115	171
Winona	4	387	621	4	447	968
Wright	10	335	511	10	426	774
Yellow Medicine	5	83	196	3	27	42
Undistributed[3]	[r]24	8,539	12,692	18	2,311	3,928
Total[4]	396	33,486	44,503	415	30,713	59,629

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Jackson and Traverse Counties are not listed because no production was reported.

[2] Data for 1976 exclude industrial sand to avoid disclosing company proprietary data.

[3] Includes Big Stone, Blue Earth, Carver, Faribault, Houston, Lac Qui Parle, Nobles, Pipestone (1976), Ramsey, Rock, and Stevens Counties, and some sand and gravel that cannot be assigned to specific counties.

[4] Data may not add to totals shown because of independent rounding.

Table 10.—Minnesota: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Agricultural limestone	598	1,534	431	1,034
Concrete aggregate	694	1,732	715	1,893
Bituminous aggregate	493	1,037	611	1,367
Macadam aggregate	92	191	W	279
Dense-graded roadbase stone	2,458	4,612	2,700	5,199
Surface treatment aggregate	708	1,446	414	782
Other construction aggregate and roadstone	516	1,213	737	1,633
Riprap and jetty stone	103	245	136	296
Railroad ballast	1,478	2,842	1,595	3,518
Filter stone	W	W	12	24
Other uses[2]	395	1,095	480	966
Total[3]	7,530	15,950	7,831	16,991

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes granite, limestone, quartzite, and traprock.

[2] Includes stone used in asphalt filler, drainfields (1976), fill (1976), mineral food and poultry grit, whiting (1976), other miscellaneous uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Isanti, Jackson, Pipestone, or Traverse Counties. Clay, Dakota, Hennepin, Itasca, Le Sueur, St. Louis, and Washington Counties each recorded production of more than 1 million tons and collectively supplied 46% of the State total.

Industrial sand was produced by Kielmeyer Construction Co., Twin City Silica, Inc., and Unisil Corp. in Rice, Washington, and Le Sueur Counties, respectively. About 84% was sold as unground material and the remainder was ground. Glass manufacture was again the principal use of industrial sand, with substantial quantities also sold for molding use, oil (hydrafrac) use, and abrasives, and small amounts for a variety of other uses.

Legislation enacted during the 1977 session authorized three Minnesota counties to impose an occupation tax on gravel producers to repair roads and bridges and to provide for future restoration of abandoned gravel pits. A maximum rate of 5 cents per cubic yard of gravel is levied in Becker County, and a maximum rate of 10 cents per cubic yard is levied in Kittson and Marshall Counties.

Stone.—Stone, produced in 24 counties, included granite, limestone, quartzite, and traprock (basalt). Dimension stone was produced at 15 quarries and crushed and broken stone at 94 quarries. Increased demand for crushed and broken granite and quartzite offset decreases in all other stone types in terms of quantity, resulting in a 4% increase in the total tonnage produced; however, the total value decreased 2%. Valued at $25.1 million, stone retained its ranking as the third leading mineral commodity produced in the State, preceded by iron ore and sand and gravel. Minnesota ranked fifth in the Nation in value of dimension stone production. Although dimension stone comprised less than one-half of one percent of the total Minnesota stone tonnage, it accounted for nearly one-third of the total stone value, with most of it sold for architectural use and as monuments. The 7.9 million tons of crushed stone were shipped by truck (71%), rail (23%), and waterway (6%).

Limestone and dolomite was quarried in 14 southeastern Minnesota counties at 78 locations, 12 fewer than in 1976. Total output declined only slightly, while the attendant value decreased 3%. Crushed limestone sales from 75 quarries totaled 5.5 million tons, valued at $11.3 million, decreases of 1% and 2%, respectively, from 1976 sales. Production of dimension limestone, which also registered decreases from the previous year, was reported by three companies operating quarries in Blue Earth, Le Sueur, and Winona Counties. Cut stone accounted for more than half of the dimension stone output. Other products, in descending order of magnitude, were house stone veneer, rough blocks, rubble, flagging, and sawed stone.

Sales of dimension and crushed granite totaling nearly 2 million tons and valued at $10.5 million were reported by 7 companies operating 14 quarries. Stearns County ranked first in granite output, with the remainder supplied by quarries in Big Stone, Lac Qui Parle, Mille Lacs, Redwood, Renville, St. Louis, and Yellow Medicine Counties. Sales of dimension granite in 1977 totaled 211,000 cubic feet, valued at $6 million, and were primarily for monuments and architectural use. Nearly all of the material was dressed at finishing plants in the State. The plant operated by Cold Spring Granite Co. at Cold Spring is reportedly the largest finishing plant for granite in the world. Crushed and broken granite production increased 22% in quantity and 32% in value over the previous year. About three-fourths of the material was sold as railroad ballast, and the remainder was mainly for use as aggregates and poultry grit.

New Ulm Quartzite Quarries, Inc., produced crushed and broken quartzite in Nicollet County near New Ulm. The output, which increased substantially over that of 1976, was sold for a variety of uses. Material produced at Jasper Stone Co.'s quartzite quarry in Rock County was used mainly in

Table 11.—Minnesota: Dimension stone[1] sold or used by producers, by use

Use	1976			1977		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough blocks	2,106	25	$126	2,284	27	$155
Cut stone	18,150	221	6,211	13,090	159	4,688
Dressed monumental	8,498	101	2,963	W	W	W
Other uses[2]	8,246	94	518	18,000	209	3,291
Total[3]	36,997	441	9,819	33,376	395	8,133

W Withheld to avoid disclosing company proprietary data; included with "Other uses."
[1] Includes granite, limestone, and quartzite.
[2] Includes stone used as rough monumental, house stone veneer, rubble, flagging (rough and dressed), sawed stone, irregular-shaped stone (1976), other rough and dressed stone, and uses indicated by symbol W.
[3] Data may not add to totals shown because of independent rounding.

Table 12.—Minnesota: Crushed limestone sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Blue Earth	4	522	989	4	511	924
Dakota	2	W	W	2	354	725
Fillmore	11	444	1,118	9	448	1,023
Goodhue	5	71	133	7	120	207
Houston	20	440	866	11	W	W
Olmsted	10	669	1,452	10	801	1,731
Scott	6	1,025	2,128	4	1,080	2,186
Steele	1	120	278	2	W	W
Wabasha	5	146	287	7	204	382
Washington	5	892	1,948	4	793	1,641
Winona	10	204	416	9	W	W
Undistributed[1]	^{r}7	965	1,993	6	1,158	2,513
Total[2]	86	5,499	11,608	75	5,469	11,330

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1] Includes Dodge, Mower, and Rice (1976) Counties, and data indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

the manufacture of grinding pebbles and tube-mill liners; however, a small amount was sold as dimension stone for other uses, and some broken material was sold as riprap and jetty stone.

Two companies produced traprock in St. Louis County for aggregates, railroad ballast, poultry grit, and other uses. Reported output decreased sharply from that of 1976.

Sulfur (Recovered Elemental).—Sulfur was recovered as a byproduct of the petroleum refining operations of Koch Industries, Inc., near Pine Bend in Dakota County, and Ashland Oil, Inc., a division of Northwestern Refining Co. Both quantity and value of sales increased substantially over those of 1976.

Vermiculite.—Production of exfoliated vermiculite derived from crude material mined outside the State was reported from three plants operated by W. R. Grace & Co. and Diversified Insulation, Inc., in Hennepin County, and by MacArthur Co. in Ramsey County. About 80% of the expanded product was used for loose fill and block insulation, with plaster and concrete aggregate, fireproofing, and horticultural uses accounting for most of the remainder.

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[1] State Liaison Officer, Bureau of Mines, Twin Cities, Minn.
[2] Liaison program assistant, Bureau of Mines, Twin Cities, Minn.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone: Jasper Stone Co	14575 Garden Rd. Golden, CO 80401	Quarry and plant	Rock.
Clay and shale:			
Acolite, Inc	Box 106 Springfield, MN 56087	Pit and plant	Brown.
Aglite, Inc	4901 West Medicine Lake Dr. Minneapolis, MN 55442	do	Hennepin.
Ochs Brick & Tile Co	Box 106 Springfield, MN 56087	do	Brown and Redwood.
Coke:			
Koppers Co., Inc	1000 North Hamline Ave. St. Paul, MN 55104	Coke ovens	Ramsey.
United States Steel Corp	Morgan Park Duluth, MN 55800	do	St. Louis.
Iron ore:			
Cleveland-Cliffs Iron Co.: Canisteo	1460 Union Commerce Bldg. Cleveland, OH 44115	Mine and concentrator.	Itasca.
The Hanna Mining Co.:	100 Erieview Plaza Cleveland, OH 44114		
Butler taconite project		Mine, concentrator, and agglomerator.	Do.
National Steel pellet project		do	Itasca and St. Louis.
Pierce		Stockpile shipments	St. Louis.
Whitney		do	Do.
Carmi		Mine; ore treated at Whitney concentrator.	Do.
Inland Steel Mining Co.: Minorca	30 West Monroe St. Chicago, IL 60603	Mine, concentrator	Itasca.
Jones & Laughlin Steel Corp., Northwest Ore Div.:	Virginia, MN 55792		
Hill Annex, Trumbull, and Delaware.		Mines and concentrator.	Do.
McKinley and Welton		do	St. Louis.
Oglebay-Norton Co.:	1200 Hanna Bldg. Cleveland, OH 44115		
Thunderbird		Mine	Do.
Fairlane plant		Concentrator and agglomerator.	Do.
Pickands Mather & Co.:	1100 Superior Ave. Cleveland, OH 44114		
Erie Commercial		Mine, concentrator, and agglomerator.	Do.
Hibbing Taconite		do	Do.
Pittsburgh Pacific Co.:	2521 1st Ave. Hibbing, MN 55746		
Knox Extension and others		Mines	Do.
Julia and Knox plants		Concentrators	Do.
Reserve Mining Co.:	Silver Bay, MN 55614		
Peter Mitchell		Mine and primary crusher.	Do.
Silver Bay plant		Concentrator and agglomerator.	Lake.
Rhude & Fryberger, Inc.: Gross-Nelson, Hull-Rust, Leonides, Rana, Sharon-Culver, and Wabigon	Box 66 Hibbling, MN 55746	Mines and concentrators.	St. Louis.
Snyder Mining Co.: Whiteside	Box 730 Buhl, MN 55713	Stockpile shipments	Do.
United States Steel Corp. Minnesota Ore Operations:	Box 417 Mountain Iron, MN 55768		
Minntac		Mine, concentrator, and agglomerator.	Do.
Plummer group		Mine and concentrator.	Itasca.
Rouchleau group		do	St. Louis.
Sherman group		do	Do.
Iron and steel: North Star Steel Co	1678 Red Rock Rd. St. Paul, MN 55164	Electric steel furnace.	Ramsey.
Lime: American Crystal Sugar Co	101 North 3rd St. Moorhead, MN 56560	Quicklime; shaft kilns.	Clay, Polk, Renville.
Manganiferous ore:			
Pittsburgh Pacific Co.: Algoma-Zeno	2521 1st Ave. Hibbing, MN 55746	Mine and concentrator.	Crow Wing.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Peat:			
Michigan Peat	Box 66388 Houston, TX 77006	Bog; processing plant.	Carlton.
Northern Peat Co	Box 416 Grand Rapids, MN 55744	do	Aitkin.
Power-O-Peat Co	Box 956 Gilbert, MN 55741	do	St. Louis.
Petroleum refineries:			
Continental Oil Co	Box 8 Wrenshall, MN 55797	Refinery	Carlton.
Koch Refining Co	Box 2302 Wichita, KS 67201	do	Dakota.
Northwestern Refining Co., a division of Ashland Oil, Inc	Drawer 9 St. Paul Park, MN 55071	do	Washington.
Sand and gravel:			
Ames Sand & Gravel, Inc	Box 2702 Fargo, ND 58102	Pit and plant	Clay.
Arsenal Sand & Gravel Co	Box 2707 New Brighton, MN 55112	do	Ramsey.
Barton Contracting Co	10300 89th Ave. North, Osseo, MN 55369	Pits and plants	Hennepin, Sherburne, Washington, Wright.
Cemstone Products Co	1520 Minnehaha Ave. St. Paul, MN 55106	Pit and plant	Washington.
Duininck Bros. & Gilchrist	Olivia, MN 56277	Pits and plants	Kandiyohi, Otter Tail, Renville, Wadena.
Fischer Sand & Aggregate, Inc	County Rd. 42 Rosemount, MN 55068	Pit and plant	Dakota.
Kielmeyer Construction Co	Nerstrand, MN 55053	Pits and plants	Dakota and Rice.
Kost Bros, Inc	Box 499 Moorhead, MN 56560	do	Clay and Wilkin.
L & K Redi-Mix, Inc	Route 5 Little Falls, MN 56345	do	Morrison.
C. S. McCrossan, Inc	Box 322 Osseo, MN 55369	Pit and plant	Hennepin.
North Star Concrete Co	Box 167 Mankato, MN 56001	Pits and plants	Le Sueur and Nicollet.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	Pit and plant	Washington.
Unisil Corp	Greenwich Office Park 4 Greenwich, CT 06830	Pit and plant; industrial sand.	Le Sueur.
Stone:			
Granite:			
Cold Spring Granite Co	Cold Spring, MN 56320	Quarries	Big Stone, Mille Lacs, Renville, St. Louis.
Do		Quarries and plant	Stearns.
The Green Co., Inc	200 14th Ave. Granite Falls, MN 56241	Quarry and plant	Yellow Medicine.
Ortonville Stone Co	Box 829 Sioux Falls, SD 57102	do	Big Stone.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	do	Stearns.
Limestone:			
Biesanz Stone Co., Inc	Box 768 Winona, MN 55987	do	Winona.
Bryan Rock Products, Inc	Box 215 Shakopee, MN 55379	Quarries and plants	Scott and Washington.
Hector Construction Co	Box 410 Caledonia, MN 55921	do	Houston and Winona.
Edward Kraemer & Sons, Inc	Plain, WI 53577	Quarry and plant	Dakota.
Lundin Construction Co., Inc	1905 3rd Ave. Mankato, MN 56001	Quarries and plants	Blue Earth and Steele.
Mankato Aglime & Rock Co	Box 254 Mankato, MN 56001	Quarry and plant	Blue Earth.
Mankato Stone Center, a division of the Babcock Co	Box 3088 Mankato, MN 56001	do	Do.
Osmundson Brothers	Adams, MN 55909	Quarries and plants	Mower.
Quarve & Anderson Co	2430 Marion Rd. SE. Rochester, MN 55901	do	Dodge, Fillmore, Olmsted, Wabasha, Winona.
River Warren Aggregates, Inc	Box 122 Chaska, MN 55318	Quarry and plant	Scott.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	Quarries and plants	Scott and Washington.
Vetter Stone Co	Route 5 Mankato, MN 56001	do	Blue Earth and Le Sueur.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Quartzite:			
Jasper Stone Co	Jasper, MN 56144	Quarry and plant	Rock.
New Ulm Quartzite Quarries, Inc	Route 3, Box 21 New Ulm, MN 56073	do	Nicollet.
Traprock (basalt):			
Arrowhead Blacktop Co	Box 6568 Duluth, MN 55806	do	St. Louis.
Ulland Brothers, Inc	Box 340 Cloquet, MN 55720	do	Do.
Sulfur, recovered elemental:			
Koch Refining Co	Box 2302 Wichita, KS 67201	Elemental sulfur recovered as a by-product of oil refining.	Dakota.
Northwestern Refining Co., a division of Ashland Oil, Inc	Drawer 9 St. Paul Park, MN 55071	do	Washington.
Vermiculite, exfoliated:			
Construction Products Div., W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Processing plant	Hennepin.
Diversified Insulation, Inc	Box 188 Hamel, MN 55340	do	Do.
MacArthur Co	936 Raymond Ave. St. Paul, MN 55114	do	Ramsey.

The Mineral Industry of Mississippi

By Owen W. Jones[1] and Alvin R. Bicker, Jr.[2]

In 1977 raw mineral production value in Mississippi totaled $492.2 million, an increase of 9.4% over that of 1976, and a new record high. Sand and gravel production quantity increased by 11%; natural gas, by 17%; and crushed stone, by 24%. Cement and special use clays registered modest increases in production. The remaining commodities were produced at approximately the same or slightly decreased rates.

The mineral industry is a small but important factor in the State's economy. Petroleum and natural gas are the principal mineral commodities produced, providing considerable employment, earnings, and taxes. Some of the mineral resources of Mississippi are lying fallow, awaiting the technology and economic conditions that could make them valuable. Iron ore was mined as early as 1887 and as recently as 1969. Lignite has been mined, in small quantities, at various times since the 1920's and presently holds the most promise for exploitation in the near future. Some other potentially valuable mineral resources include salt from the numerous intrusive salt domes, heavy minerals from barrier-island beach sands, bauxitic clay, carbon dioxide, glauconite, sandstone, shell, and tripoli.

Table 1.—Mineral production in Mississippi[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	1,487	$8,849	1,483	$8,841
Lime do	57	1,248	49	1,079
Natural gas million cubic feet	70,762	50,241	82,995	60,589
Petroleum (crude) thousand 42-gallon barrels	46,072	328,957	43,022	352,844
Sand and gravel[3] thousand short tons	12,033	20,394	13,353	25,375
Stone do	1,762	2,968	2,176	3,933
Combined value of cement (masonry and portland), clays (ball and fuller's earth), magnesium compounds, natural gas liquids, and sand and gravel (industrial)	XX	37,205	XX	39,573
Total	XX	449,862	XX	492,234
Total 1967 constant dollars	XX	230,914	XX	ᵖ242,967

ᵖPreliminary. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes ball clay and fuller's earth; value included in "Combined value" figure.

[3] Excludes industrial sand and gravel; value included in "Combined value" figure.

Table 2.—Value of mineral production in Mississippi, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	$34,415	--	
Amite	W	--	
Benton	W	W	Clays.
Bolivar	W	$263	Sand and gravel.
Calhoun	W	--	
Carroll	W	W	Sand and gravel, clays.
Chickasaw	W	264	Stone.
Clarke	66,927	--	
Clay	1,400	W	Sand and gravel, stone.
Copiah	4,638	4,264	Sand and gravel.
Covington	W	--	
De Soto	W	263	Sand and gravel.
Forrest	2,690	W	Do.
Franklin	W	--	
George	125	36	Sand and gravel.
Greene	W	--	
Grenada	W	--	
Hancock	649	374	Sand and gravel.
Harrison	22	W	Do.
Hinds	2,954	W	Clays.
Holmes	2,329	2,077	Sand and gravel.
Humphreys	W	--	
Itawamba	W	W	Clays, sand and gravel.
Jackson	W	W	Magnesium compounds, lime.
Jasper	61,329	--	
Jefferson	936	--	
Jefferson Davis	11,237	101	Sand and gravel.
Jones	17,441	W	Clays.
Kemper	W	W	Do.
Lamar	45,184	W	
Lauderdale	W	W	Clays.
Lawrence	34	W	
Lee	W	W	Clays.
Leflore	W	--	
Lincoln	7,438	125	Clays, sand and gravel.
Lowndes	17,517	20,133	Cement, sand and gravel, stone, clays.
Madison	2,647	--	
Marion	7,126	611	Sand and gravel.
Marshall	W	W	Clays.
Monroe	7,796	W	Clays, sand and gravel.
Noxubee	W	W	Clays, stone.
Oktibbeha	W	--	
Panola	W	W	Clays, sand and gravel.
Pearl River	245	--	
Perry	479	W	Sand and gravel.
Pike	3,675	875	Do.
Prentiss	7	W	Clays.
Quitman	W	W	Do.
Rankin	16,362	W	Cement, stone.
Scott	464	--	
Simpson	2,864	--	
Smith	11,891	W	Clays, natural gas liquids.
Stone	W	815	Sand and gravel.
Sunflower	10	14	Clays.
Tate	W	285	Sand and gravel.
Tippah	W	W	Clays.
Tishomingo	W	W	Stone, sand and gravel.
Walthall	10,215	200	Sand and gravel.
Warren	W	1,660	Do.
Washington	W	W	Do.
Wayne	30,807	--	
Wilkinson	8,404	--	
Winston	W	W	Clays.
Yalobusha	W	W	Sand and gravel.
Yazoo	22,663	1,623	Do.
Undistributed[2]	46,945	458,251	
Total[3]	449,862	492,234	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties were not listed because no production was reported: Alcorn, Attala, Choctaw, Claiborne, Coahoma, Issaquena, Lafayette, Leake, Montgomery, Neshoba, Newton, Pontotoc, Sharkey, Tallahatchie, Tunica, Union, and Webster.

[2] Includes value of petroleum and natural gas (1977) and other mineral production that cannot be assigned to specific counties and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Mississippi business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	947.0	964.0	+1.8
Unemployment	do	62.0	71.0	+14.5
Employment (nonagricultural):				
Mining	do	6.9	7.6	+10.1
Manufacturing	do	218.9	230.0	+5.1
Contract construction	do	39.1	40.5	+3.6
Transportation and public utilities	do	34.7	35.9	+3.5
Wholesale and retail trade	do	141.4	149.3	+5.6
Finance, insurance, real estate	do	28.5	29.9	+4.9
Services	do	101.8	107.4	+5.5
Government	do	156.2	160.5	+2.7
Total nonagricultural employment	do	727.5	761.1	+4.6
Personal income:				
Total	millions	$10,746	$12,019	+11.8
Per capita		$4,543	$5,030	+10.7
Construction activity:				
Number of private and public residential units authorized		6,942	8,231	+18.6
Value of nonresidential construction	millions	$105.7	$143.3	+35.6
Value of State road contract awards	do	$97.6	$125.0	+28.1
Shipments of portland and masonry cement to and within the State	thousand short tons	896	1,020	+13.8
Mineral production value:				
Total crude mineral value	millions	$449.9	$492.2	+9.4
Value per capita, resident population		$191	$206	+7.8
Value per square mile		$9,428	$10,316	+9.4

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

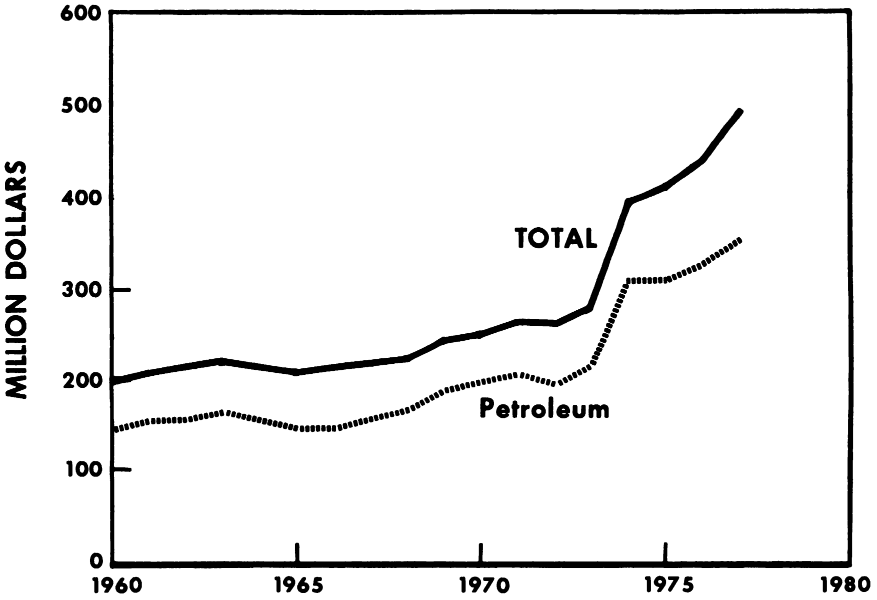

Figure 1.—Value of petroleum and total value of mineral production in Mississippi.

Mining employment, as recorded by the Mississippi Employment Security Commission includes employment in oil and gas extraction, and mining and quarrying of nonmetallic minerals. In 1976 oil and gas extraction employed an estimated 5,780 people, which represented 82% of the mining employment total. In the same year, nonmetallic mining employment was 1,230 (18% of mining total), for a total of 7,010 in the mining category. In 1977, the comparable employment figures were 6,420 in oil and gas extraction and 1,190 in nonmetallic mining, for a total of 7,610, an 8.6% increase over that of 1976. The 7,610 mining workers represented 1.4% of nonmanufacturing employment and 1% of total establishment-based nonagricultural wage-earning and salaried employees.

Trends and Developments.—Mineral processing continued as an important sector of the Mississippi economy in 1977. The chief activities were concerned with petroleum refining, petrochemical production, and mineral fuels for electricity generation. Approximately 120 million barrels of crude oil were refined. Shipments of petroleum products had an estimated value of $1,500 million; petrochemical shipments, $750 million. Value of total electricity generated using mineral fuels exceeded $600 million. Total value added by manufacturing in the State was $3,685.5 million, of which 20% was due to mineral-related manufacturing. Total value of industry shipments was $9,517.7 million, of which 24% was due to the mineral-related manufacturing industries. Total cost of materials used in manufacturing was $5,806 million, of which 27% was in the mineral-related industries.

The State has 5 petroleum refineries, 12 gas-processing plants, 2 cement plants, a number of brick and tile plants, and several petrochemical plants.

Oil and gas severance tax collections are equivalent to approximately 4% of the State Tax Commission general fund collections. In 1977 the oil severance tax collected was $19.4 million, and the gas severance tax was $5.1 million. In addition, lease bonuses for State-owned mineral lands accounted for $1.3 million, for a total of $25.9 million.

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), under contract with the Department of Energy, was conducting tests relative to Ocean Thermal Energy Conversion (OTEC) powerplants. These plants use the temperature difference between deep cold water and the sun-warmed surface waters to develop electric power. The NOAA Office of Ocean Engineering at the National Space Technology Laboratory in Bay St. Louis is carrying out the tests. Ergon, Inc., a Jackson based energy service, began constructing a 10,000-barrel-per-day crude topping plant at Vicksburg, near the Yazoo River Diversion Canal.

Legislation and Government Programs.—The Water Resources Division of the U.S. Geological Survey has numerous programs concerning surface and ground water in the State. Some of these programs are continuous and are operational yearly, including surface water stations, ground water stations, quality-of-water stations, and bridge site investigations. They continued investigations on special programs such as the Tennessee-Tombigbee project, and salt dome hydrology project. A cooperative program with the Mississippi Geological Survey has been in continuous operation for a number of years. This program consists of electrical logging of water wells throughout the State.

The U.S. Department of Energy is responsible for several programs that were in operation prior to its inception. These programs were originated by the Energy Research and Development Administration (ERDA, now part of the Department of Energy). ERDA continued a monitoring program at the Tatum Dome, site of the Dribble and Salmon Events, which were tests to determine the effects of detonations of nuclear devices. Another ERDA program was directed by the Office of Waste Isolation. This program is a continuation of the research and investigation of Mississippi salt domes for the purpose of nuclear-waste disposal. During 1977 this investigation was more or less a compilation of available data and the assimilation of data supplied to the contractor in late 1976. Data acquired during the preliminary investigative phase enabled the contractor to eliminate a number of salt domes and to select three domes for further geologic evaluation, which was scheduled to begin in early 1978 and continue into 1979.

The Corps of Engineers continued to collect data on the geological, hydrological, mineral, and other aspects of the Tennessee-Tombigbee Waterway. Data was furnished by numerous contractors, in addition to the material generated by Corps personnel. The Mississippi Geological Survey was among the contractors. The title of this project was "Study of Geological, Mineralogical and Paleontological Resources of the Tennessee-Tombigbee Waterway and the Preservation of Critical Geological Data." Although a report was made on the geology and mineral resources, the main objective of the program was the preservation and storage of selected data from test wells drilled by the Corps.

The most important State legislation concerning the mineral industry during the 1977 legislative session was the Surface Mining and Reclamation Act. All minerals exclusive of oil and gas are regulated by this legislation. The Mississippi Geological Survey was named to administer the act and to promulgate rules and regulations to implement the act. The act will become effective in April 1978 and any person engaged in a surface mining operation shall be required to conform and comply with all applicable provisions of the act. Sand and gravel operations smaller than 4 acres are exempted from the act's provisions.

Other legislative action concerning the mineral industry was an increase in the permit fee required to drill a test well for oil and gas from $100 to $200.

In October Governor Cliff Finch announced the first step in a federal court lawsuit to settle Mississippi's offshore boundary dispute with Louisiana. Finch said he had notified Governor Edwin Edwards of Louisiana that Mississippi was requesting a hearing by an Associate Director of the Coastal Zone Office, and was awaiting word from the Federal authorities setting the date for a hearing to submit its evidence. He said the Associate Director was required to render a decision within 6 months.

The Mississippi Geological Survey entered into a contract with ERDA to investigate the potential geothermal energy sources in Mississippi. The original completion date was projected as early as 1978; however, the original 35-county area was expanded and the projected completion date was extended. The report should be published by late 1978 or early 1979.

Surface geologic mapping continued on county and quadrangle scale. The investigation of the geology and mineral resources of Clarke County and a 7-1/2-minute topographic quadrangle in Simpson County continued during 1977. The survey contributed to the geology and mineral resources of the Tennessee-Tombigbee Waterway. A paper was prepared for inclusion in a future U.S. Geological Survey professional paper describing the Mississippian strata and associated minerals that outcrop within the State.

The Ground-Water Section of the Mississippi Geological Survey compiled data on the ground water resources of Clarke and Simpson Counties, to be included in the reports being prepared by the Surface Geology Section.

Landfill sites for solid waste and hazardous waste were investigated under a cooperative program with the Mississippi State Board of Health. The Mississippi Geological Survey's responsibility in this endeavor is the geological feasibility of the acceptance of the proposed sites. Investigation continued for a publication of an environmental geology report on a topographic quadrangle adjacent to the Jackson area.

Transportation.—The Mississippi State Port Authority began test work in connection with construction of ilmenite ore storage facilities at the State port in Gulfport. The storage facilities will be used by E. I. du Pont de Nemours & Co., Inc. in connection with its titanium dioxide plant under construction in western Harrison County at DeLisle. Du Pont plans to import ilmenite through the port. The ore will be stored for transshipment by rail to the DeLisle plant which is expected to be operational in 1979.

Environment.—Concern with the environment is illustrated by the following quote from the 1977 annual report of the Mississippi Power Co., one of the major power companies in Mississippi: "To protect and preserve the environment, the company has invested through 1977 more than $68.1 million for pollution control equipment at its generating plants, including electrostatic precipitators and modern closed-cycle-cooling-water systems. The company estimates that during 1978 an additional $3.5 million will be spent at its generating plants for protection of air and water."

A $1.9 billion nuclear plant is planned for construction on the Yellow Creek embankment of Lake Pickwick in northeast Mississippi. A yearend public hearing at Iuka brought objections from the Sierra Club and other environmentalist groups. The plant, which had been previously approved by the Nuclear Regulatory Commission (NRC) staff, is to be built by the Tennessee Valley Authority (TVA). Construction is scheduled to begin early in 1978 if the NRC's Safety and Licensing Board approves the project. The TVA says the plant design meets all radiation safety standards set by both the State and Federal governments. Environmentalists object that there is no safe method for storing nuclear wastes. Three state utility companies in favor of the planned plant say that energy needs in northeast Mississippi are increasing by 7% per year.

The Mississippi Power and Light Co. Grand Gulf nuclear powerplant under construction in central western Mississippi near Port Gibson was more than 40% completed at yearend.

The proposed Du Pont titanium dioxide plant at DeLisle was the target of an environmental group known as Save the Bay, Inc. They contend that plant discharges could harm drinking water supplies of the Bay of St. Louis. The company and Save the Bay disagree over the validity of tests on shrimp. The tests showed high death rates among the shrimp when exposed to chemicals similar to waste discharges that would occur at the plant. The coordinator for the tests at the Laboratory testified that several factors indicate the shrimp were not healthy at the outset of the tests. The microbiologist who made the tests says he believes the shrimp were healthy before the tests began. Both sides agreed a second test should be conducted.

The Mississippi Marine Resources Council sponsored a study to determine if there is need for improved or additional access to the State's coastal shoreline, as part of a Shorefront Access and Preservation Study.

In late 1977 the Mississippi Pollution Control Commission ordered the Vicksburg Chemical Co. to equip one of its buildings with air emission controls that could cost the company about $500,000. The plant produces potassium nitrate, a main ingredient in fertilizer. Nitric acid, a basic ingredient in the process, is believed to be the substance responsible for the irritating emissions.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The value of petroleum and natural gas production totaled $413.4 million, an increase of 9% over 1976 value, and constituted 84% of the total raw minerals production value for the State. Natural gas production registered an appreciable increase in volume, 17% more than the 1976 volume.

At yearend, there were 489 oil pools and 114 gas pools producing in 514 fields in the State. Producing wells totaled 3,185.

NONMETALS

The combined production value of nonmetals and natural gas liquids was $78.8 million and represented 16% of the State's mineral production value. Nonmetal production value in 1977 was 11.5% higher than comparable 1976 value.

Cement.—Marquette Cement Manufacturing Co. in Rankin County, and United Cement Co. in Lowndes County produced and sold portland cement. Marquette also produced and sold masonry cement, and United sold masonry cement. Portland cement accounted for 94% of the total production. Ready-mix companies and highway and other contractors used 74% of the total portland cement production. Raw materials used in making portland cement included limestone, marl, cement rock, clay, sand, iron ore, gypsum, and anhydrite. Both plants used natural gas to fire their kilns, and both used the wet process. Production increased approximately 3% over that of 1976.

Clays.—The 1977 output totaled 1.5 million short tons valued at $808 million, down slightly from 1976 levels. Average unit value in 1977 was $5.96 per ton, essentially the same as last year's price of $5.95.

Common clay used for heavy clay products and lightweight aggregate was mined from 18 operations by 15 companies in 13 counties; bentonite from 3 operations by 3 companies in 3 counties; ball clay from 2 operations by 1 company in 1 county. Leading counties in descending order of production were Noxubee, Hinds, Monroe, Tippah, and Benton.

Common clay was used primarily for brick manufacture, lightweight aggregate, and sewer tile, and accounted for approximately two-thirds of the total clay output.

Commercial clay deposits occur throughout the State. Although total clay production ranked only 12th among the States, Mississippi is a major supplier of some of the special use clays. It ranks second among the States in production of bentonite, which is mined in Itawamba, Monroe, and Smith Counties. This is the nonswelling, high-calcium type of bentonite, used in foundry work as an absorbent and oil clarifier. Mississippi ranks third in production of ball clay and also fuller's earth.

In 1977 the Mississippi Geological Survey submitted a number of clay samples to the U.S. Bureau of Mines for ceramic analyses, which were performed under a cooperative agreement between the Bureau and the Survey. The clay samples were from test holes drilled by the Survey in Clarke County in eastern Mississippi. Results of the analyses will be published at a later date upon completion of the investigation.

Lime.—Corchem, Inc., produced quicklime at Pascagoula in Jackson County from stone quarried in Alabama. The lime was consumed in Mississippi in the production of magnesite. Output decreased about 14% from that of 1976.

Magnesium Compounds.—In Jackson County, Corhart Refractories Co. recovered magnesium compounds from seawater at Pascagoula. The magnesium compounds are used in the manufacture of refractories. Mississippi ranked fifth among the eight States producing magnesium compounds. Total U.S. production was 830,475 short tons valued at $127,716,000.

Perlite.—Although not mined in Mississippi, perlite continued to be expanded by the Johns-Manville Perlite Corp. at Natchez in Adams County. The product was used in roofing insulation products.

Sand and Gravel.—Production of construction sand and gravel totaled 13.4 million short tons valued at $25.4 million or $1.90 per ton, compared with 1976 production of 12.0 million short tons valued at $20.4 million. Average unit price increased 12%. A total of 53 companies with 78 operations reported production from 27 of the State's 82 counties. Leading counties in descending rank of production were Copiah, Lowndes, Monroe, Yazoo, and Holmes. These 5 counties produced 49% of the State's output of construction sand and gravel. Construction sand and gravel production was principally used for concrete aggregate and concrete products, roadbase and coverings, and asphaltic concrete aggregate.

Sand and gravel is ranked number two in value among the nonmetals produced in the State. The principal gravel sources include the Tuscaloosa Formation of Cretaceous age and the Citronelle Formation of the Pleistocene. Heavy-mineral concentrations (ilmenite, kyanite, staurolite, zircon, etc.) are known in the barrier-island sands offshore in the Gulf of Mexico, but these deposits have not been exploited commercially.

Table 4.—Mississippi: Construction sand and gravel sold or used by producers

	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	4,208	$7,045	$1.67
Gravel	9,145	18,330	2.00
Total or average	13,353	25,375	1.90

Table 5.—Mississippi: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	5,950	$11,870	$1.99
Concrete products	1,338	3,194	2.39
Asphaltic concrete	1,941	3,479	1.79
Roadbase and coverings	3,134	5,457	1.74
Fill	890	1,154	1.30
Other	99	222	2.24
Total[1] or average	13,353	25,375	1.90

[1] Data may not add to totals shown because of independent rounding.

Stone.—Six companies crushed stone at seven quarries for cement manufacture, agricultural limestone, riprap, jetty stone, concrete aggregate, and other uses. Output increased 23% to 2.2 million tons valued at $3.9 million. Leading producers were Texas Industries, Inc., Mississippi Stone Co., Inc., and Marquette Cement Manufacturing Co.

Among the States, Mississippi ranked third in production of marl.

Crushed and broken limestone was produced in Chickasaw, Clay, Lowndes, Noxubee, Rankin, and Tishomingo Counties. Marl was produced in Rankin County.

Dimension stone has been produced in the past, but present stone production is mostly limestone, which is used for agricultural lime and cement manufacture. Two cement plants and five agricultural-lime plants operated in the State.

Sulfur.—Recovery of sulfur from refinery and sour natural gases was reported by Shell Oil Co. in both Clarke and Rankin Counties, by Chevron, USA, Inc., in Jackson County, and by Gulf Oil Corp. in Lamar County. Production totaled 289,352 long tons, while sales totaled 335,099 long tons, the difference by draw down of the beginning stock. Total value of the recovered sulfur sold or used was $16.7 million.

METALS

Ores of aluminum and iron are found in Mississippi. The aluminum ore is of limited quality and it is not commercially feasible to exploit until extractive and processing costs are reduced to more acceptable levels. Iron ores have, in the past, been produced at several locations within the State. Mining began as early as 1887 and continued sporadically and in small quantities until as recently as 1969, when a Kemper County operation was discontinued. No further iron ore mining has been reported since that time.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Marquette Cement Manufacturing Co	2200 1st American Center Nashville, TN 37238	Plant	Rankin.
United Cement Co	Box 185 Artesia, MS 39736	do	Lowndes.
Clays:			
Atlas Brick Co	Box 67 Shuqualak, MS 39361	3 mines	Noxubee.
Delta-Macon Brick & Tile Co., Inc	R.F.D. 3, Box 2 Macon, MS 39341	Mine and plant	Do.
Filtrol Corp	3250 East Washington Blvd. Los Angeles, CA 90023	do	Itawamba and Smith.
Holly Springs Brick & Tile Co., Inc	Box 310 Holly Springs, MS 38635	do	Marshall.
International Minerals & Chemical Corp.	Box 346A Aberdeen, MS 39730	Mine	Monroe.
Jackson Ready Mix Concrete, division of Delta Industries, Inc.	Box 1292 Jackson, MS 39205	do	Hinds.
Tri-State Brick & Tile Co., Inc	Box 9787 Jackson, MS 39206	Mine and plant	Do.
Lime: Corchem, Inc	Box 1707 Pascagoula, MS 39567	Plant	Jackson.
Magnesium compounds: Corhart Refractories Co.	1600 West Lee St. Louisville, KY 40210	do	Do.
Sand and gravel:			
American Sand & Gravel Co	Box 272 Hattiesburg, MS 39401	Stationary plant	Forrest.
Blaine Gravel Co	Box 268 Crystal Springs, MS 39059	do	Copiah.
Green Bros. Gravel Co., Inc	Route 4, Box 17 Franklinton, LA 70438	do	Do.
Hammett Gravel Co	Box 207 Lexington, MS 39095	Mine and plant	Holmes.
W. J. Runyon & Son, Inc	3312 Oak St. Vicksburg, MS 39180	Stationary plant	Warren.
Traxler Gravel Co., division of Delta Ind., Inc.	Box 1292 Jackson, MS 39205	Stationary plant and dredge.	Copiah.
Stone:			
Marquette Cement Manufacturing Co	20 North Wacker Dr. Chicago, IL 60606	Quarry	Rankin.
State Department of Agriculture and Commerce.	Box 352 West Point, MS 39773	do	Clay.

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The Mineral Industry of Missouri

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Missouri Department of Natural Resources for collecting information on all minerals.

By Waldemar M. Dressel[1] and James A. Martin[2]

In 1977, the value of Missouri minerals reached a new alltime high for the 16th consecutive year. At $893 million, the value was approximately 14% higher than in 1976. Higher unit prices for most of the major items rather than increases in quantity produced was the major reason for the increase in value.

Principal minerals produced in order of value were lead, cement, stone, iron ore, coal, zinc, lime, sand and gravel, clays, copper, and silver.

Lead mining continued at about the same rate as in 1977; however, with lead prices moving from 26 cents to 33 cents per pound during the year, substantial increases in value were noted. The strike at the 80,000-ton-per-year ASARCO Incorporated smelter at Glover, which began on September 1, 1976, was settled about June 1, 1977. The combined values of the lead and the associated zinc, copper, and silver account for approximately 44% of the State's total mineral production value.

Zinc production declined to slightly less than 82,000 tons as Missouri dropped to second place behind Tennessee. Zinc prices declined from a high of 37 cents to a low of 30.5 cents per pound by yearend.

Barite production continued to decline, but higher prices resulted in an increase in value.

Iron ore production declined because of a relatively low demand for ore. The two companies operating in Missouri were having difficulty in marketing pellets. A 5-week shutdown by Pilot Knob Pellet Co. and a 6-week shutdown by Meramec Mining Co. during the summer to reduce iron pellet stock failed to correct the situation. Pilot Knob scheduled a 3-week shutdown at yearend, and in December, Meramec Mining Co. announced the closing of the Pea Ridge mine and the layoff of approximately 1,000 workers. Bethlehem Steel Co., one of the partners of Meramec Mining, turned over its ownership rights to St. Joe Minerals, the other partner. There were no reopening plans at yearend.

The aluminum reduction plant at New Madrid, with two potlines rated at 70,000 tons per year each, operated at near maximum capacity throughout the year, providing employment to 850 persons.

A new glass plant employing 240 persons and using sand and limestone from Missouri began operations at Flat River in October. The plant manufactures specialty bottles for the pharmaceutical and cosmetic industries.

The value of mineral production was approximately $186 per capita compared with a national average of $356; the value per square mile was $12,820 compared with a national average of $21,324.

Table 1.—Mineral production in Missouri[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite thousand short tons	124	$3,860	117	$4,061
Cement:				
Masonry do	76	2,718	82	3,286
Portland do	4,353	142,976	4,654	155,945
Clays do	2,133	14,915	[2]2,373	[2]16,892
Coal (bituminous) do	6,075	56,934	6,366	66,089
Copper (recoverable content of ores, etc.) short tons	11,050	15,382	11,737	15,681
Iron ore (usable) thousand long tons, gross weight	2,133	W	W	W
Lead (recoverable content of ores, etc.) short tons	500,991	231,458	500,255	307,156
Lime thousand short tons	1,731	49,907	1,723	51,529
Natural gas million cubic feet	29	10	20	8
Petroleum (crude) thousand 42-gallon barrels	61	W	W	W
Sand and gravel thousand short tons	15,375	26,550	14,002	31,473
Silver (recoverable content of ores, etc.) thousand troy ounces	2,277	9,905	2,363	10,916
Stone thousand short tons	47,546	98,327	49,615	105,297
Zinc (recoverable content of ores, etc.) short tons	83,530	61,812	81,689	56,203
Combined value of asphalt (native), clays (fuller's earth and kaolin, 1977), phosphate rock, and values indicated by symbol W	XX	70,406	XX	68,836
Total	XX	785,160	XX	893,372
Total 1967 constant dollars	XX	282,265	XX	440,968

W Withhheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes fuller's earth and kaolin; included in "Combined value" figure.

Table 2.—Value of mineral production in Missouri, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adair	W	--	
Andrew	W	W	Stone.
Atchison	W	$1	Sand and gravel.
Audrain	$2,626	3,299	Clays.
Barry	514	445	Stone.
Barton	W	W	Stone, asphalt.
Bates	W	W	Stone.
Benton	W	188	Do.
Bollinger	W	54	Sand and gravel.
Boone	W	W	Stone, sand and gravel, clays.
Buchanan	W	W	Stone.
Butler	W	W	Sand and gravel, stone, clays.
Caldwell	W	509	Stone.
Callaway	3,552	W	Clays, stone, sand and gravel.
Camden	W	308	Sand and gravel, stone.
Cape Girardeau	13,306	13,869	Cement, stone, sand and gravel, clays.
Carroll	W	--	
Carter	30	33	Sand and gravel.
Cass	W	860	Stone.
Cedar	W	W	Do.
Chariton	W	W	Stone, sand and gravel.
Christian	W	W	Stone.
Clark	W	W	Stone, sand and gravel.
Clay	4,213	W	Do.
Clinton	391	W	Stone.
Cole	W	W	Stone, sand and gravel.
Cooper	W	W	Do.
Crawford	W	W	Lead, zinc, copper, stone, sand and gravel, silver, clays.
Dade	505	458	Stone.
Dallas	W	5	Sand and gravel.
Daviess	W	W	Stone, sand and gravel.
De Kalb	W	W	Stone.
Dent	12	16	Do.
Douglas	453	240	Sand and gravel, stone.
Franklin	W	1,355	Do.
Gasconade	W	W	Clays, stone.
Gentry	W	W	Sand and gravel, stone.
Greene	W	W	Lime, stone.
Grundy	W	W	Stone, sand and gravel.
Harrison	W	W	Do.
Henry	W	W	Stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Missouri, by county[1] [2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Hickory	W	W	Stone.
Holt	W	W	Do.
Howard	W	W	Stone, sand and gravel.
Howell	W	$695	Do.
Iron	W	W	Lead, zinc, iron ore, silver, copper, stone, sand and gravel.
Jackson	W	W	Cement, stone, sand and gravel.
Jasper	W	W	Stone, sand and gravel.
Jefferson	W	W	Cement, stone, sand and gravel, clays.
Johnson	$554	492	Stone.
Knox	W	W	Do.
Laclede	W	W	Stone, sand and gravel.
LaFayette	W	W	Do.
Lawrence	W	W	Stone.
Lewis	W	W	Sand and gravel, stone.
Lincoln	W	W	Stone, sand and gravel.
Livingston	W	W	Stone, clays, sand and gravel.
Macon	W	263	Sand and gravel.
Madison	W	W	Stone.
Maries	W	--	
Marion	W	W	Stone, sand and gravel.
McDonald	W	W	Stone.
Mercer	W	676	Do.
Miller	W	W	Sand and gravel, stone.
Moniteau	W	240	Stone.
Monroe	W	W	Stone, clays.
Montgomery	W	W	Clays, stone, sand and gravel.
Morgan	W	154	Stone.
Newton	W	549	Stone, sand and gravel.
Nodaway	W	W	Do.
Oregon	W	W	Sand and gravel, stone.
Osage	W	W	Clays, stone.
Ozark	W	W	Sand and gravel.
Pemiscot	341	243	Do.
Perry	W	W	Stone, sand and gravel.
Pettis	W	W	Stone.
Phelps	W	W	Stone, sand and gravel, clays.
Pike	W	W	Cement, stone, clays, sand and gravel.
Platte	3,353	W	Clays, stone, sand and gravel.
Polk	189	216	Stone.
Pulaski	916	808	Stone, sand and gravel.
Putnam	W	W	Stone.
Ralls	W	W	Cement, stone, clays.
Randolph	W	556	Stone.
Ray	W	1,237	Sand and gravel, stone.
Reynolds	W	W	Lead, zinc, copper, silver, sand and gravel, stone.
Ripley	279	249	Sand and gravel.
St. Charles	W	W	Stone, sand and gravel, clays.
St. Clair	W	W	Stone.
St. Francois	W	W	Lime, stone.
St. Louis	44,813	W	Cement, sand and gravel, stone, clays.
St. Louis City	407	W	Sand and gravel.
Ste. Genevieve	W	W	Lime, stone, sand and gravel.
Saline	1,944	1,339	Stone.
Scotland	W	W	Do.
Scott	W	W	Clays, stone, sand and gravel.
Shannon	117	202	Stone.
Shelby	W	W	Do.
Stoddard	776	1,288	Sand and gravel.
Stone	W	W	Stone.
Taney	W	W	Sand and gravel, stone.
Texas	W	187	Stone, sand and gravel.
Vernon	W	1,421	Stone.
Warren	W	W	Clays, stone.
Washington	78,131	85,608	Iron ore, lead, barite, zinc, copper, silver, phosphate rock, sand and gravel.
Wayne	3,148	2,580	Stone, sand and gravel.
Webster	32	80	Do.
Worth	W	W	Stone.
Wright	W	W	Do.
Undistributed[3]	624,558	772,656	
Total[4]	785,160	893,372	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Dunklin, Linn, Mississippi, New Madrid, Schuyler, and Sullivan.

[2] Value of petroleum is based on an average price per barrel for the State.

[3] Includes value of stone, natural gas, petroleum, and coal that cannot be assigned to specific counties, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Missouri business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	2,130.0	2,220.0	+4.2
Unemployment do	133.0	131.0	-1.5
Employment (nonagricultural):			
Mining do	8.6	8.3	-3.5
Manufacturing do	424.9	436.9	+2.8
Contract construction do	72.2	76.5	+6.0
Transportation and public utilities do	125.5	128.3	+2.2
Wholesale and retail trade do	428.5	441.8	+3.1
Finance, insurance, real estate do	95.1	95.9	+.8
Services do	326.5	335.7	+2.8
Government do	316.5	320.8	+1.4
Total nonagricultural employment do	1,797.8	1,844.2	+2.6
Personal income:			
Total millions	$28,569	$31,943	+11.8
Per capita	$5,968	$6,654	+11.5
Construction activity:			
Number of private and public residential units authorized	22,749	28,081	+23.4
Value of nonresidential construction millions	$334.4	$423.3	+26.6
Value of State road contract awards do	$220.0	$240.0	+9.1
Shipments of portland and masonry cement to and within the State thousand short tons	1,773	1,835	+3.5
Mineral production value:			
Total crude mineral value millions	$785.2	$893.4	+13.8
Value per capita, resident population	$164	$186	+13.4
Value per square mile	$11,267	$12,820	+13.8

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Labor, Employment, and Safety.—According to the Division of Employment Security, Missouri Department of Labor and Industrial Relations, the mining industry employed 8,425 workers in 1977, an increase of 3% over the 8,179 employed in 1976. A total of 108 workers were employed by the crude petroleum and natural gas industry. The primary smelting and fabrication industry employed 15,542, and the nonmetallic mineral product processing industry employed 13,095.

Missouri had four metal and nonmetal mining fatalities in 1977. One resulted from an underground mine accident, two from surface mine accidents, and one from a mill accident.

Safety awards were presented at the annual meeting of the Missouri Division of Labor Standards to the following operations:

Underground.—Buick mine, AMAX of Missouri; Bushy Creek mine, St. Joe Minerals.

Surface facilities.—Indian Creek mine, St. Joe Minerals; Pilot Knob Pellet Co.

Surface coal.—Empire mine, Pittsburg & Midway Coal Mining Co.

St. Joe Mineral's Bushy Creek mine received the award for the most improved safety program.

The Missouri Limestone Producers Association (MLPA) presented safety awards to 30 limestone operations, as follows: Big Spring Quarry, Carthage Marble, Cullor Limestone Co., Farmers Stone (Trager quarries), Fullerton Stone Co., Galloway Limestone Co., Gilliam Rock, Inc., Gordon Quarries, Griesemer Stone Co. (Plant No. 3), Hall & Riley Quarries, Hilty Quarries, Inc., Jeff-Cole Quarries, Inc., Joerling Bros. Quarries, Joplin Stone, Kaser Corp., Kelly Lime & Rock, Magruder Limestone Co., Inc., Martin Marietta Aggregates, Martinsburg Limestone Co., Midwest Minerals, Morgans Material, Inc., Orrick Stone, Riverview Stone & Material, Southwest Mo Stone, Union Quarries (Lenexa Plant 2), William Rock Industries, Inc. (Clinton quarry, Montrose quarry and Snyder quarry), and Williamsvill Stone.

Energy.—The Missouri Coal Research and Development Committee, made up of individuals of the Federal, State, and private sectors who were active in research, production, or utilization of coal, prepared an interim report on the "Role of Coal in Missouri." This report was prepared in cooperation with the Division of Geology and Land Survey and the Missouri Energy Agency, both of the Department of Natural Resources.

A proposal, underway since 1974, for constructing a coal gasification plant at Palmyra to produce gas from high-sulfur coal was still being pursued by Associate Electric Cooperatives and Farmland Industries.

Additional proposals for coal gasification plants to be built in central and north Missouri were made to the Mid-Missouri Council of Governments and the Green Hills Planning Commission. These proposals remained under consideration at yearend.

Construction of Union Electric (UE) Co.'s nuclear plant in Callaway County continued at a slower rate. Completion of Unit 1, a 1,150-megawatt unit, has been extended for a year until 1982. Unit 2 completion date has been extended to 1987. Plans for a "trash to energy" project in the St. Louis area were dropped by UE.

Environment.—Water pollution control has been actively pursued by the mining industry. Public Law 92-500, Federal Water Pollution Control Act amendment of 1972, has as its goal the restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters. Section 208 of this law relates to the areawide waste treatment management including the runoff from agriculture, construction projects, industry, municipal areas, and mining areas. The mining industry, which has historically cooperated with State agencies for clean air and water, selected representatives to work on the Advisory Committee for 208 planning, headed up by the Department of Natural Resources, Division of Environmental Quality. A work plan was set up and preliminary studies are being reported to citizen groups in all areas of the State. A report on the effects of coal mining is in preparation.

The final report of "An Interdisciplinary Investigation of Environmental Pollution by Lead and Other Heavy Metals From the Industrial Development in the New Lead Belt of Southeastern Missouri," which began in 1972, was published in May 1977.[3] This two-volume report summarizes the 5-year study by the University of Missouri in cooperation with the Missouri mining industry and Federal and State agencies.

Water quality in the abandoned zinc mine area of southwestern Missouri was reported on by the Geological Survey.[4] This study showed that the zinc content of the runoff water around some of the old tailings areas ran as high as 16,000 micrograms per liter and that a need exists to control metal mining waste areas after mining has ceased as well as during the active mining period.

Tailings dams at two abandoned operations in Madison County and St. Francois County were overtopped and eroded, thereby dumping tailings into Saline Creek and Big River respectively. The owner of the dam in Madison County repaired the break to prevent further erosion and modified the drainage to prevent further mishaps. St. Francois County, the owner of the second tailings area, was working with the State and other parties to stop continued erosion problems and to repair the dam.

Missouri Portland Cement Co.'s St. Louis plant was charted with violating air emission standards. The company requested a variance to allow time to carry out its $2 million dust collection program to supplement the $3.5 million program already completed. Ironically a variance of the noise pollution ordinance was needed to allow the company to operate its air pollution equipment which enabled it to meet the air quality standard.

The NL Industries titanium pigment plant in St. Louis has had a long history of failure to meet the county's air quality standards. In June an agreement was made whereby NL was to pay $125,000 in penalties and $120,000 to reimburse the Federal Government for a study of the plant. Lawsuits were filed between the company and the St. Louis County air quality control group and various local residents. One stack met the requirements of the law, and a variance was requested on a second. However, in October several yellow alerts, which require a 25% reduction in production, and a red alert, which requires a 50% reduction in operations, increased the pressure against the company. The company laid off 400 employees, over half of its work force, and indicated that a further reduction was imminent. Titanium pigment requirements are expected to be made up by foreign imports.

The wilderness area issue remains a concern to the mining industry in Missouri. The Federal Government owns 1.45 million acres of acquired lands in the Mark Twain National Forests. Mineral leases were held on 35,226 of the acres. Over 25% of the State's mineral production value is derived from these lands. Numerous prospecting permits have been applied for in accordance with procedures established under the Mineral Leasing Act of 1920, but none have been issued for several years. In recent years any decision to lease Federal lands requires consideration of land use plans and environmental factors, and since such studies have not yet been made no prospecting permits have been granted.

Review and Evaluation of Roadless Areas (RARE II) proposals for Missouri in 1977 included: Bell Mountain, 8,530 acres in Iron

County; Paddy Creek, 6,888 acres in Texas County; Piney Creek, 8,430 acres, Barry and Stone Counties; Rockpile Mountain, 4,170 acres in Madison County; Devil's Backbone, 6,830 acres in Ozark County; Irish Wilderness, 17,562 acres in Oregon County; Anderson Mountain, 2,622 acres in Iron County; Spring Creek, 4,910 acres, Douglas and Howell Counties; Swan Creek, 6,945 acres in Christian County; and Big Creek, 8,890 acres in Taney County.

In 1976 Alpha Portland Cement Co. obtained a conditional permit from the St. Louis County Planning Commission to operate a sand and gravel dredging operation in the Meramec River Valley in St. Louis County. The issuance of the conditional permit was challenged by environmental groups, local citizens, and the State Director of Natural Resources. The case remained in litigation at the end of 1977.

Exploration, Geologic Studies, and Mapping.—The U.S. Department of the Interior's Geological Survey was active in Missouri on studies involving topographic mapping surface and subsurface hydrologic conditions, earthquake hazards, and radioactive resources. The earthquake hazard study in the New Madrid area of southeast Missouri includes adjoining areas of Arkansas, Illinois, Kentucky, and Tennessee. The operational safety of nuclear reactors within the area of influence sensitive to geologic hazards is a matter of prime concern. A preliminary study of the potential uranium and thorium resources of the Precambrian igneous rocks of the St. Francois Mountains of southeast Missouri was completed, and an open file report was prepared. The study concluded that the granites in the area should be considered as potential source rocks for uranium deposits.

The U.S. Department of the Interior's Geological Survey and Bureau of Mines were active in several cooperative programs with the Division of Geology and Land Survey, Missouri Department of Natural Resources. The Geological Survey is involved in cooperative studies on the tar sand potential of southwestern Missouri, in a geologic study of the Rolla 2-degree quadrangle, and in funding input of coal information into the National Coal Data System. A report entitled "Inventory of Strippable Tar Sands in Southwestern Missouri" resulted from an exploration drilling program by the State Division of Geology and Land Survey.[5] This program was funded under a grant from the U.S. Geological Survey and is being continued under a contract from the U.S. Department of Energy (DOE). The DOE program was established to improve the estimates of the location, depth, size, and quality of heavy oil and tar sand deposits in western Missouri and to determine their geologic setting and reservoir characteristics, and the physical and chemical properties of the oil. The Rolla 2 degree-project is a geologic study, including geochemical and geophysical evaluations, of an approximately 7,500-square-mile area in southeast Missouri. This study is particularly important since it includes much of the area of past and present lead, iron, and barite mining as well as a large part of the National Forest on which companies are seeking permits to explore for new deposits.

The Missouri Division of Geology and Land Survey conducted a project to evaluate coal reserves. This project, funded in part by a Bureau of Mines grant, included field mapping and a drilling program of an area in north-central Missouri. A spinoff from this program was the discovery of a thick limestone bed at a relatively shallow depth in an area where the need for near-surface sources of concrete aggregate, roadstone, and agricultural stone is well known.

Exploration activities for lead, zinc, and copper continue at a reduced level in areas near the Viburnum Trend as well as in southwest Missouri. Getty-Azcon had an active program underway in the Boss area, evaluating the lead potential in the Bonneterre Formation in the eastern part of their Precambrian copper-iron prospect lease.

Legislation and Government Programs.—The Official Manual of the State of Missouri for 1977-78 includes a 33-page feature article entitled "Underground Treasures—The Story of Mining in Missouri."[6] The history of mining in Missouri is traced from the Indians' use of flintstone for tools and weapons, iron oxide for pigment, and clay for pottery and proceeds through the early French lead mining period in the late 18th century, through the 19th century, to the present date.

Severance tax bills (H.B. 68 and H.B. 463) were introduced into the State Legislature but were not brought out of the House Mines and Mining Committee.

Dam Safety legislation (H.B. 646) proposed by the Department of Natural Resources and supported by the mining industry was not acted upon favorably.

The mining industry has supported limited liability legislation (H.B. 275), but such proposals have not been acted upon. The mining industry has areas that would be suitable for hunting and fishing; however, these areas are closed to the general public because of possible liability actions which could be brought against the landowner in the event of an accident.

At yearend mining companies were beginning to understand the ramifications of two acts passed by the 95th Congress of the United States in 1977. Public Law 95-164, Federal Mine Safety and Health Act of 1977, required substantial changes in the mine safety programs of the metal and nonmetal mining companies. Public Law 95-87, Surface Mining Control and Reclamation Act of 1977, regulated the surface effect of coal mining activities nationwide.

The Office of Surface Mining, U.S. Department of the Interior, held hearings in the State on the proposed interim regulations as they apply to the coal industry. Meetings were also held with the State Land Reclamation Commission, Missouri Department of Natural Resources, to discuss means of bringing the State law into compliance to enable the State to administer the Federal Act.

Hearings by the Occupational Safety and Health Administration, U.S. Department of Labor, on proposed national ambient air standards for lead were held during the year. The Missouri lead industry is concerned that a standard be established which would be technically and economically achievable.

REVIEW BY MINERAL COMMODITIES

METALS

In 1977 metals accounted for about half of the value of the State's mineral production. The percentage attributable to metal production has been declining as the unit value of nonmetal commodities has continued to increase.

Aluminum.—Noranda Aluminum, Inc., operated both its 70,000-ton-per-year potlines at near capacity for the entire year.

Copper.—Copper production increased slightly during 1977. Lead-to-copper production ratios at various mines ranged from 2:1 to 135:1 with a weighted average of approximately 43:1. Since copper is a byproduct of lead production and since lead-to-copper ratios are so variable, decreases or increases in lead production are not necessarily reflected by equivalent decreases or increases in copper production.

Iron Ore.—Iron ore shipments from the State's two underground mines dropped from the 1976 level. Pilot Knob Pellet Co. had a 5-week shutdown during the summer and a 3-week shutdown at yearend. Meramec Mining Co. had a 6-week shutdown for pellet inventory roduction during the summer, and in December it announced the closing of the Pea Ridge mine, the largest underground iron mine in the United States, which had employed approximately 1,000 workers. The mine and mill were placed on standby for a year while future market conditions and possible reopening were investigated. The mine reportedly has a substantial reserve of iron ore.

Lead.—Although Missouri lead output was down slightly from that of 1976, the State accounted for 84% of the Nation's lead production. The labor strike at the ASARCO smelter at Glover, which began on September 1, 1976, continued to June 1977. Ozark Lead Co., which normally supplies 80% of the concentrates smelted at the Glover smelter, continued to operate. Lead concentrates were shipped to smelters outside the United States.

No lead mines were closed, nor were any new lead mines opened or planned for the foreseeable future.

Missouri's measured and indicated lead reserves at the end of 1977 were estimated to be approximately 20.6 million tons, a 60% decrease from previously published estimates.[7]

Economic Geology devoted the entire May issue to the geology of the Viburnum Trend, southeast Missouri.[8] Seventeen papers were presented by geologists from mining and exploration companies, the U.S. Geological Survey, and universities.

Table 4.—Missouri: Tenor of lead ore milled and concentrates produced in 1977

Total material ________short tons__	8,925,602
Metal content of ore:	
Copper _____________percent__	0.19
Lead _______________do____	5.95
Zinc________________do____	1.24
Concentrates produced and average content:	
Copper ___________short tons__	24,067
Recovery ratio ______percent__	0.27
Average copper content __do____	25.95
Lead ____________short tons__	702,772
Recovery ratio ______percent__	7.91
Average lead content ____do____	73.19
Zinc______________short tons__	152,221
Recovery ratio ______percent__	1.70
Average zinc content ____do____	58.41

Table 5.—Missouri: Mine production (recoverable) of silver, copper, lead, and zinc

	1975	1976	1977
Mines producing: Lode	9	9	9
Material sold or treated: Lead ore thousand short tons	8,468	8,658	8,925
Production:			
Quantity:			
Silver troy ounces	2,525,042	2,277,013	2,362,752
Copper short tons	14,258	11,050	11,737
Lead do	515,958	500,991	500,255
Zinc do	74,867	83,530	81,689
Value:			
Silver thousands	$11,161	$9,905	$10,916
Copper do	18,308	15,382	15,681
Lead do	221,862	231,458	307,156
Zinc do	58,396	61,812	56,203
Total[1] do	309,726	318,556	389,957

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Missouri: Total value of mineral production and production and value of lead in Missouri and the United States

Year	Total value of Missouri mineral production (thousands)	Lead production					
		Missouri				United States	
		Quantity (short tons)	Value (thousands)	Percent of U.S. production	Percent of world production	Quantity (short tons)	Value (thousands)
1973	$512,634	487,143	$158,711	80.8	12.7	603,024	$196,465
1974	691,049	562,097	252,944	84.7	14.9	663,870	298,742
1975	722,728	515,958	221,862	83.0	[r]13.6	621,464	267,230
1976	785,160	500,991	231,458	82.2	[r]13.6	609,546	281,610
1977	893,372	500,255	307,156	84.4	13.3	592,491	363,789

[r] Revised.

Silver.—Missouri continued to be the sixth largest silver-producing State and accounted for 2,363,000 troy ounces, or 6% of the silver produced in the Nation. Silver is a byproduct from the smelting of lead and zinc ores.

Zinc.—Missouri produced 81,700 short tons, or 18%, of the Nation's recoverable zinc but lost its first place position to Tennessee. There are no zinc smelters in Missouri. The production of zinc is dependent upon the lead market since zinc is a byproduct of lead mining and milling. The price of zinc declined from 37 cents per pound at the beginning of the year to 35.5 cents per pound at yearend.

NONMETALS

In 1977 nonmetals accounted for 41% of the total value of mineral production. Barite, lime, and sand and gravel production were down slightly with cement, clay, and stone production increasing over those of 1976. The value of the nonmetal commodities showed an increase in every instance.

Barite.—Barite production declined for the sixth consecutive year to almost 50% of what it was in 1971. Six companies operating nine washing plants produced 117,000 tons of barite from the low-grade residual deposits in Washington County.

The decrease in primary barite production did not decrease the amount of ground and crushed barite sold since some raw barite from other areas is shipped to Missouri for grinding and blending with Missouri barite. Four companies operating six mills sold 156,000 tons of crushed and ground barite worth $11.7 million. Approximately two-thirds of the barite was sold for use in drilling muds; the remainder was used for the manufacture of chemicals and as filler or extender in paints, rubber, and other products. The barite sold for use other than well drilling accounted for 60% of the total value of the crushed and ground barite sold.

Cement.—Seven cement plants operating in Missouri produced over 4.5 million tons of portland cement. This was a 5% increase over 1976 output. Sales increased approximately 7%, and as a result yearend stocks were 8% less than in 1976. Masonry cement production increased 26% over 1976. Approximately 77% of the cement was used by ready-mix companies, 9% each by highway contractors and concrete product manufacturers, and the remaining 4% to 5% by building material dealers, government agencies, and other miscellaneous contractors and customers.

Marquette Cement Co.'s plans for replacing its Cape Girardeau facility with a new 1-million-ton-per-year plant were nearing completion.

Clays.—Production increases were noted in all categories of clay production. The average unit value of fire clay remained virtually constant, while the average value of common clay and shale increased approximately 30%. Gasconade, Audrain, and Montgomery Counties each produced over 200,000 tons of fire clay, and their combined production amounted to 78% of the total. Over 136,000 tons of fire clay was produced in Callaway County. Monroe, Phelps, St. Charles, and Warren Counties accounted for a combined total of about 50,000 tons.

Seventy-five percent of the common clay and shale was used for portland cement manufacture. Other uses for this clay include the manufacture of face brick, com-

Table 7.—Missouri: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	7	7
Production	4,334,448	4,551,103
Shipments from mills:		
Quantity	4,352,669	4,653,933
Value	$142,975,522	$155,944,849
Stocks at mills, Dec. 31	376,149	345,790

Table 8.—Missouri: Masonry cement salient statistics

(Short tons)

	1976	1977
Number of active plants	4	4
Production	69,691	87,825
Shipments from mills:		
Quantity	75,773	82,154
Value	$2,718,087	$3,285,571
Stocks at mills, Dec. 31	7,974	11,685

Table 9.—Missouri: Clays sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Other clays		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1973	829	7,563	1,565	2,371	[1] [2]157	[1] [2]1,692	2,551	11,626
1974	924	10,761	1,542	2,391	[2]99	W	2,565	13,151
1975	854	11,285	1,209	1,928	W	W	2,168	13,214
1976	809	11,723	1,256	2,124	[2]68	[2]1,068	2,133	14,915
1977	872	12,529	1,432	3,190	W	W	2,373	16,892

W Withheld to avoid disclosing company proprietary data; excluded from total.

[1] Bentonite.

[2] Kaolin.

mon brick, flower pots, roof tiles, and expanded aggregate. An 18% increase in clay for common brick and a 10% increase in face brick usage of clay were noted over 1976. Fuller's earth is also produced for absorbent and carrier.

Lime.—Ash Grove Cement Co. and Mississippi Lime Co. produced high-calcium lime, and Valley Mineral Products Corp. produced dolomitic quicklime and refractory dolomite. With production in excess of 1.7 million tons, Missouri ranked as the third largest producer of lime.

Perlite.—J. J. Brouk & Co. produced expanded perlite at a plant in St. Louis. Production was about 5,000 tons, of which 2,000 was used for construction aggregate, 1,000 for horticultural and agricultural aggregate, 1,000 for insulation, and the remainder for other uses.

Pigments.—Crude iron oxide pigment was mined by Meramec Mining Co. Natural and synthetic iron oxide pigments were produced by Cities Service Co. in St. Louis.

Phosphate Rock.—Meramec Mining Co. produced apatite concentrate as a byproduct of iron ore beneficiation at the Pea Ridge mine. Production declined along with the iron ore production brought about by a 6-week shutdown during the summer and the closing of the mine in December.

Sand and Gravel.—Sand and gravel production declined from 15.3 million to 14 million tons. The total value, however, increased over 18% to $31.5 million. Industrial sand production increased to over 1 million tons but was still about 28% below the record production of 1974. Over 68% of the sand and gravel produced was used as concrete or asphaltic concrete aggregate, 20% as roadbase and coverings, and 10% as fill.

Table 10.—Missouri: Construction and industrial sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Processed:				
Sand	10,714	14,073	8,067	14,941
Gravel	2,979	5,746	4,931	9,493
Unprocessed sand and gravel	781	886	--	--
Industrial gravel	901	5,596	1,004	7,039
Total	15,375	[1]26,550	14,002	31,473

[1] Data do not add to total shown because of independent rounding.

Table 11.—Missouri: Construction sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	4,723	8,024	6,514	13,263
Concrete products	534	918	904	2,113
Asphaltic concrete	1,787	3,199	1,618	3,312
Roadbase and coverings	2,409	3,663	2,479	4,006
Fill	4,611	4,439	1,402	1,586
Other uses	409	712	69	106
Total[1]	14,474	20,954	12,998	24,435

[1] Data may not add to totals shown because of independent rounding.

Table 12.—Missouri: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	8,428	17,820	7,866	17,700
Concrete aggregate	^{r}5,794	^{r}12,270	6,869	15,210
Cement manufacture	6,254	10,010	6,016	10,470
Dense-graded roadbase stone	4,308	9,333	5,429	12,130
Bituminous aggregate	2,576	6,174	3,748	8,721
Agricultural limestone	5,038	11,120	3,571	8,342
Macadam aggregate	2,570	4,334	3,405	5,754
Lime manufacture[2]	3,430	5,511	3,205	5,380
Riprap and jetty stone	2,675	4,101	3,180	5,660
Surface treatment aggregate	3,047	7,344	2,727	6,565
Railroad ballast	1,220	2,768	1,408	2,336
Sulfur dioxide	W	W	596	1,310
Flexstone	W	675	W	394
Asphalt filler	W	W	76	198
Mineral food	136	446	56	330
Other filler	64	320	52	264
Filter stone	--	--	24	49
Terrazzo and exposed aggregate	W	W	4	216
Other uses[3]	^{r}2,000	^{r}5,187	1,380	3,671
Total[4]	47,542	97,412	49,612	104,700

^{r}Revised. W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, granite, sandstone, and marble.

[2] Includes dead-burned dolomite.

[3] Includes stone used for roofing granules, glass manufacture, mine dusting, whiting, chemicals, unspecified uses, and uses indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Stone.—Carthage Marble Co., Heyward Granite Co., Weiler Marble Co., Inc., and Ozark Stone Products, Inc., quarried dimension stone for rough monumental stone (25%), rough blocks, dressed flagging, sawed building stone, dressed monumental stone, and other uses. Output declined 29% to 2,892 tons valued at $597,000. Crushed stone was produced by 173 companies at 291 quarries for roadstone, concrete aggregate, cement, roadbase aggregate, and other uses. Output increased 4% to 49.6 million tons valued at $104.7 million. Leading producers were Moline Consumers, Mississippi Lime Co., and Fred Weber, Inc.

Among the States, Missouri ranked fourth in output of total crushed stone and in production of crushed limestone.

Sulfur.—Amoco Oil Co. recovered a significant tonnage of sulfur at its Sugar Creek oil refining operation in Jackson County. St. Joe Minerals Corp. and AMAX Lead Co. of Missouri recovered sulfuric acid from their respective lead smelters at Herculaneum and Boss. The bulk of the sulfuric acid was sent to plants manufacturing fertilizer.

Vermiculite.—Vermiculite was expanded in St. Louis by J. J.Brouk & Co. and W. R. Grace for use as insulation, lightweight aggregate, soil conditioner, fertilizer carrier, fireproofing, and other miscellaneous uses.

Table 13.—Missouri: Bituminous coal production from strip mines in 1977, by county[1]

County	Production (thousand short tons)
Audrain	10
Barton	508
Bates	1,719
Henry	1,536
Howard	280
Macon	724
Putman	959
Randolph	606
Vernon	285
Total	6,627

[1] Information from 1977 Statistical Report, Division of Labor Standards, Inspection Section, Mining, of the Department of Labor & Industrial Relations of the State of Missouri.

MINERAL FUELS

Mineral fuels comprised slightly more than 7% of the value of the State's mineral production. Coal was the only mineral fuel produced in significant quantities.

Fifteen strip mines operated in the State to produce 6.4 million tons of coal. This was the second consecutive year that a new coal production record was achieved.

According to the Missouri Oil and Gas Council, natural gas production all but ceased except for a few individually owned wells for private home use. Crude oil production increased. Of the 54 wells drilled in 1977, 1 was completed as an oil well and 2 as gas wells. The oil well, located in Jackson County, was completed in the Lagonda Formation (Squirrel Sandstone) at a depth of 560 feet. The gas wells drilled in Cass County were producing from 220 and 250 feet.

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[1] State Liaison Officer, Bureau of Mines, Rolla, Mo.

[2] Geologist and Chief, Mineral Resources Section, Department of Natural Resources, Division of Geology and Land Survey, Rolla, Mo.

[3] Wixson, B. G., and others. The Missouri Lead Study. The Interdisciplinary Lead Belt Team, University of Missouri, Rolla and Columbia, Mo., NSF Grant AEN 74-22935-A01, Final Progress Rept., May 1972 to May 1977, v. 1-2, 1977 (NTIS PB 274-242 $16.25).

[4] Barks, J. H. Effects of Abandoned Lead and Zinc Mines and Tailings Piles on Water Quality in the Joplin Area, Missouri. Pres. at the 1977 AIME-SME Fall Meeting, St. Louis, Mo., Oct. 19-21, 1977, reprint No. 77 AG-308 ($1.00 AIME member; $2.50 nonmember).

[5] Wells, J. S. Inventory of Strippable Tar Sands in Southwestern Missouri. Mo. Dept. Nat. Res., Div. Geol. and Land Survey, Misc. Pub., 1977 ($1.00).

[6] Burford, J. Underground Treasures—The Story of Mining in Missouri. State of Missouri, Official Manual, 1977-78.

[7] Ryan, J. P., and J. M. Hogue. Lead-1977, BuMines Mineral Commodity Profile 1977, p. 6.

[8] Economic Geology. V. 72, No. 3, May 1977, pp. 337-490.

Table 14.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt, native:			
Bar-Co-Roc Asphalt Co	Box 11 Iantha, MO 64753	Mine	Barton.
Silica Rock Asphalt Corp	Sheldon, MO 64784	do	Vernon.
Barite:			
Dresser Industries, Inc	Box 8 Potosi, MO 63604	Mine and mill	Washington.
General Barite Co	402 S. 2nd St. DeSoto, MO 63020	Mine	Do.
Milchem, Inc	Mineral Point, MO 63660	Mine and mill	Do.
NL Industries, Inc	Box 2808 St. Louis, MO 63111	do	St. Louis and Washington.
Cement:			
Alpha Portland Cement Co	15 S. 3rd St. Easton, PA 18043	Plant and quarry	St. Louis.
Dundee Cement Co.[1,2]	Box 317 Dundee, MI 48131	do	Pike.
Marquette Cement Manufacturing Co.[1,2]	First American Center Nashville, TN 37238	do	Cape Girardeau.
Missouri Portland Cement Co.[1,2]	7751 Carondelet Ave. St. Louis, MO 63105	do	Jackson and St. Louis.
River Cement Co	Festus, MO 63028	do	Jefferson.
United States Steel Corp.[1,2]	600 Grant St. Pittsburgh, PA 15230	do	Ralls.
Clays:			
Dresser Industries, Inc	2 Gateway Center Pittsburgh, PA 15222	Mine and plant	Callaway, Gascondade, Montgomery, Warren.
Kaiser Aluminum & Chemical Corp.	Box 499 Mexico, MO 65265	do	Audrain, Callaway, Gasconade, Montgomery, Warren.
United States Gypsum Co	Mexico, MO 65265	do	Franklin and Gasconade.
Coal:			
Peabody Coal Co	301 North Memorial Dr. St. Louis, MO 63102	do	Henry, Macon, Randolph.
Pittsburg & Midway Coal Mining Co.	Kansas City, MO 64105	do	Barton and Bates.
Industrial sand:			
Martin Marietta Co	110 East Main St. Rockton, IL 61072	Plant and pit	Jefferson.
Penn Glass Sand Corp	Box 187 Berkley Springs, WV 25411	do	St. Charles and St. Louis.
Unisil Corp	Greenwich Office Park Four Greenwich, CT 06830	do	Jefferson.

See footnotes at end of table.

Table 14.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Iodine:			
Mallinckrodt Chemical Works	3600 North 2nd St. St. Louis, MO 63147	Plant	St. Louis.
Syntex Agribusiness	1919 West Sunshine Springfield, MO 65805	do	Greene.
West Agro-Chemical, Inc	501 Santa Fe Kansas City, MO 64102	do	Jackson.
Iron ore:			
Meramec Mining Co	Route 4 Sullivan, MO 63080	Underground mine	Washington.
Pilot Knob Pellet Co	Box 26 Ironton, MO 63650	do	Iron.
Lead:			
AMAX Lead Co. of Missouri[3]	Boss, MO 65440	do	Do.
Cominco American, Inc.[3]	Bixby, MO 65439	do	Do.
Ozark Lead Co.[3]	Sweetwarter, MO 63680	do	Reynolds.
St. Joe Minerals Corp.[3]	Viburnum, MO 65566	do	Crawford, Iron, Reynolds, Washington.
Lime:			
Ash Grove Cement Co	1000 Ten Main Center Kansas City, MO 64105	Plant	Greene.
Mississippi Lime Co.[2]	7 Alby St. Alton, IL 62002	do	St. Genevieve.
Valley Mineral Products Corp	902 Syndicate Trust Bldg. St. Louis, MO 63101	do	St. Francois.
Perlite, expanded:			
J. J. Brouk & Co	1367 S. Kingshighway Blvd. St. Louis, MO 63110	do	St. Louis.
Sand and gravel:			
Green Quarries, Inc	Box 257 Carrollton, MO 64633	Dredge	Carroll, Chariton, Ray.
Holliday Sand & Gravel Co	6811 West 63rd St. Overland Park, KS 66202	do	Various.
List & Clark Construction Co	do	do	Platte.
Missouri Gravel Co	Box 9 LaGrange, IL 60525	Pit and plant	Lewis.
Riverside Sand & Dredging	5000 Bussen Rd. St. Louis, MO 63129	Dredge	St. Louis.
St. Charles Sand Co	Rt. 1, Box 252 Hazelwood, MO 63042	Plant	Do.
Winter Bros. Material Co	13098 Gravois Rd. St. Louis, MO 63127	do	Do.
Stone:			
Ash Grove Cement Co	Box 70 Butler, MO 64730	Quarries	Bates, Greene, Jackson, Vernon.
Grodon Bros. Quarries, Inc	Box 127 Forest City, MO 64451	do	Andrew and Holt.
Midwest Precote Co	7600 East 17th St. Kansas City, MO 64126	do	Clay and Platte.
Missouri Pacific Railroad Co	210 North 13th St., Rm. 200 St. Louis, MO 63103	do	Wayne.
Moline Consumers	313 16th St. Moline, IL 61265	do	Jefferson, Knox, Lewis, Monroe, Pike, Ralls, St. Louis, Shelby, Wayne.
Fred Weber, Inc	7929 Alabama Ave. St. Louis, MO 63111	do	Jefferson, St. Charles, St. Louis.
West Lake Quarry & Material Co.	Rt. 1, Box 206, Tuussig Rd. Bridgeton, MO 63042	do	Cape Girardeau, St. Louis, Scott.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 01109	Plant	St. Louis.

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[1] Also clays.
[2] Also stone.
[3] Also silver, copper, and zinc.

The Mineral Industry of Montana

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Montana Bureau of Mines and Geology for collecting information on all minerals.

By George T. Krempasky[1] and Don C. Lawson[2]

The value of mineral production in Montana in 1977 was $691 million, an increase of 9% over that of 1976. The combined production value of the mineral fuels (excluding natural gas liquids) accounted for 69% of the total 1977 output value. The combined value of metals produced accounted for 20% of the total output of 1977, and the nonmetals combined value of production accounted for 11% of the total output value.

Based on value of production, Montana ranked first in talc and vermiculite production, fourth in silver and copper, and seventh in gold compared with production from other States.

Exploration activities for all known mineral commodities present in the State continued at a relative high rate. Major programs were underway seeking gold, silver, copper, platinum-group metals, uranium, and tungsten. Oil and gas exploration continued; however, a decline in drilling was noted in 1977.

Table 1.—Mineral production in Montana[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony short tons	150	$318	164	$663
Barite thousand short tons	W	W	10	W
Clays do	192	W	224	3,557
Coal (bituminous) do	26,231	128,534	27,226	161,567
Copper (recoverable content of ores, etc.) short tons	91,111	126,827	86,203	115,167
Gem stones	NA	170	NA	100
Gold (recoverable content of ores, etc.) troy ounces	24,075	3,017	22,348	3,314
Iron ore (usable), gross weight thousand long tons	18	W	W	W
Lead (recoverable content of ores, etc.) short tons	92	43	106	65
Lime thousand short tons	224	5,980	223	7,705
Natural gas million cubic feet	42,563	18,941	46,819	33,663
Petroleum (crude) thousand 42-gallon barrels	32,814	276,419	32,680	280,470
Pumice thousand short tons	5	8	5	7
Sand and gravel do	4,786	7,336	4,867	10,421
Silver (recoverable content of ores, etc.) thousand troy ounces	3,279	14,262	3,367	15,558
Stone:				
Crushed thousand short tons	3,464	7,842	3,680	7,923
Dimension do	4	152	3	114
Talc do	225	2,960	226	2,947

See footnotes at end of table.

Table 1.—Mineral production in Montana[1] —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Zinc (recoverable content of ores, etc.) short tons	64	$47	79	$54
Combined value of cement (masonry and portland), fluorspar, gypsum, natural gas liquids, peat, phosphate rock, tungsten ore, vermiculite, and items indicated by symbol W	XX	43,433	XX	47,893
Total	XX	636,289	XX	691,188
Total 1967 constant dollars	XX	326,607	XX	p341,170

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Farmers Potash Co., Burlington-Northern, and CF Industries were in a joint exploration venture to collect data and analyze opportunities of the potash resources of northeastern Montana. Present studies indicate potash at one potential site at a depth of 8,300 feet; the only practical method of recovery would involve in situ solution mining.

The Federal Bentonite division of Aurora Metal Co. asked State and Federal officials for mining permits to produce 300,000 tons of bentonite annually. If all permits are granted, the operation will be the first in northeastern Montana. Present plans call for construction of a plant to crush, dry, refine, and eventually package the bentonite. The mining of bentonite will, if approved, be from State and Federal owned mineral lands. Federal Bentonite holds mining claims that total 20,200 acres. It is anticipated that the acreage to be disturbed during the initial stages of mining is about 180 acres. The projected mine life if all claims are to be mined is in excess of 20 years.

The discovery of a graphite zone 40 feet wide in the Helena area has been reported. The operating company is in the planning stages of submitting an application as required by Montana law to commence mining. Initial plans, although unconfirmed, call for a 500-ton-per-day operation.

Montana's 45th Legislature completed its business on April 19, 1977. Approximately 125 bills related to the mineral industry were introduced during the session. Bills enacted and signed into law by the Governor and considered to be of major significance to the industry included an extension from a 1-year permit to a 5-year permit for coal strip mines under the mine reclamation laws of Montana; granting emergency energy powers; a change in coal tax distribution; providing for royalty interests to pay a share of the resource indemnity trust tax; a change in metal-mine taxation from a net proceeds basis to a gross proceeds basis; redefining a small miner; a change in the method of computing the oil producers' severance tax; a tax relief for new gas wells producing from a depth of 5,000 feet or greater; and the regulation of manufacture and distribution of petroleum products.

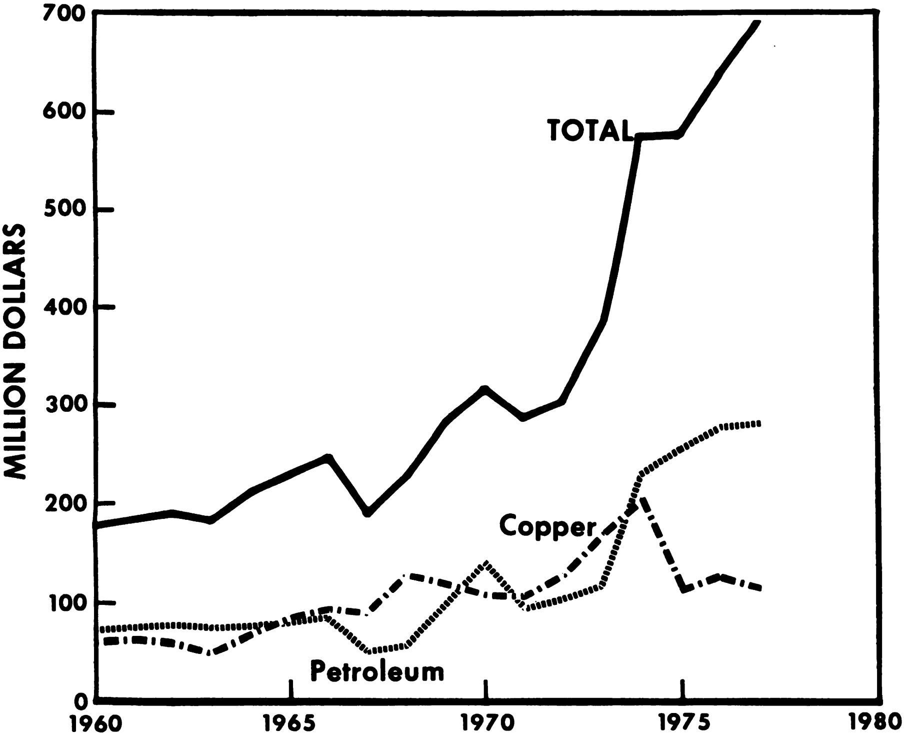

Figure 1.—Value of copper, petroleum, and total value of mineral production in Montana.

Table 2.—Value of mineral production in Montana, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Beaverhead	$567	$479	Stone, silver, sand and gravel, zinc, gold, lead, copper.
Big Horn	W	53	Sand and gravel.
Blaine	W	--	
Broadwater	W	6	Gold, silver, lead, zinc, copper.
Carbon	7,685	W	Clays, stone, sand and gravel.
Carter	W	W	Clays, stone.
Cascade	1,030	W	Sand and gravel, stone.
Chouteau	88	162	Sand and gravel.
Custer	W	W	Sand and gravel, tungsten.
Daniels	5	11	Sand and gravel, stone.
Dawson	3,405	444	Do.
Deer Lodge	W	7,902	Lime, stone, sand and gravel, tungsten, clays.
Fallon	W	--	
Fergus	W	1,103	Gypsum, sand and gravel, clays, lead, stone, gold, zinc, silver.
Flathead	1,333	1,495	Sand and gravel, stone.
Gallatin	12,532	18,120	Cement, sand and gravel, stone, clays.
Garfield	(2)	2	Stone.
Glacier	W	--	
Golden Valley	13	56	Sand and gravel.
Granite	2,289	1,773	Silver, copper, stone, tungsten, gold, sand and gravel, lead, zinc.
Hill	63	30	Sand and gravel, stone.
Jefferson	13,805	13,825	Cement, stone, sand and gravel, silver, lead, gold, zinc, copper, clays.
Judith Basin	W	W	Gypsum, silver, lead, zinc.
Lake	W	427	Sand and gravel, gold, silver, lead, zinc.
Lewis and Clark	W	181	Sand and gravel, stone, gold, zinc, lead, silver.
Liberty	W	34	Sand and gravel.
Lincoln	W	13,140	Vermiculite, stone, sand and gravel, lead, silver, zinc.
McCone	W	--	
Madison	W	3,119	Talc, gold, copper, silver, stone, lead, zinc.
Meagher	W	W	Iron ore, stone.
Mineral	266	31	Sand and gravel, stone.
Missoula	W	W	Stone, barite, sand and gravel.
Musselshell	15,040	62	Sand and gravel.
Park	W	W	Stone, sand and gravel.
Petroleum	9	31	Do.
Pondera	W	W	Sand and gravel.
Powder River	W	7	Pumice.
Powell	W	W	Phosphate rock, stone, sand and gravel, gold, silver, lead.
Prairie	10	--	
Ravalli	W	W	Stone, sand and gravel, fluorspar, peat.
Richland	23,406	W	Lime, sand and gravel, stone.
Roosevelt	W	75	Stone.
Rosebud	W	W	Sand and gravel.
Sanders	356	709	Antimony, stone.
Sheridan	W	16	Sand and gravel.
Silver Bow	141,811	W	Copper, silver, gold, sand and gravel.
Stillwater	W	24	Sand and gravel, stone.
Sweet Grass	8	16	Sand and gravel.
Teton	W	174	Sand and gravel, stone.
Toole	W	100	Sand and gravel.
Treasure	953	704	Clays, stone.
Valley	W	50	Sand and gravel.
Wibaux	W	--	
Yellowstone	W	W	Sand and gravel, lime, stone, clays.
Undistributed[3]	411,612	626,825	
Total[4]	636,289	691,188	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Phillips, Wheatland, and Yellowstone National Park Counties are not listed because no production was reported.

[2] Less than 1/2 unit.

[3] Includes natural gas, natural gas liquids, petroleum, coal, and stone production that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Montana business activity

	1976	1977^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ---- thousands--	332.0	343.0	+3.3
Unemployment ---- do----	20.0	22.0	+10.0
Employment (nonagricultural):			
Mining ---- do----	6.1	6.1	--
Manufacturing ---- do----	23.7	24.2	+2.1
Contract construction ---- do----	13.8	15.8	+14.5
Transportation and public utilities ---- do----	19.5	20.2	+3.6
Wholesale and retail trade ---- do----	63.6	66.3	+4.2
Finance, insurance, real estate ---- do----	10.8	11.4	+5.6
Services ---- do----	47.8	49.2	+2.9
Government ---- do----	65.7	70.6	+7.5
Total nonagricultural employment ---- do----	251.0	263.8	+5.1
Personal income:			
Total ---- millions--	$4,282	$4,661	+8.9
Per capita ----	$5,664	$6,125	+8.1
Construction activity:			
Number of private and public residential units authorized ----	4,750	5,627	+18.5
Value of nonresidential construction ---- millions--	$75.0	$70.5	-6.0
Value of State road contract awards ---- do----	$95.0	$85.0	-10.5
Shipments of portland and masonry cement to and within the State thousand short tons--	339	354	+4.4
Mineral production value:			
Total crude mineral value ---- millions--	$636.3	$691.2	+8.6
Value per capita, resident population ----	$845	$908	+7.5
Value per square mile ----	$4,324	$4,698	+8.6

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

The Anaconda Company went out of existence as a Montana corporation on January 12, 1977, when the company was merged with the Atlantic Richfield Co. (ARCO). The Anaconda name will be retained by ARCO, which reportedly plans to pump up to $1 billion into Anaconda to develop its ore resources and production plants. The merger was backed by officials of the State of Montana, who stated the pact would be in Montana's interests partly because Anaconda needed the money to bring its Montana operations into compliance with pollution control regulations.

Officials of ARCO feel that there is still at least as much mineral in the Butte area as has been extracted since mining began in the 1880's. Mineral production from Silver Bow County, approximately 98% from the Butte area, is shown in table 4. Anaconda has entered into a 3-year contract with the labor unions at its Montana operation.

The Anaconda Co. closed its Arbiter plant in Anaconda and its precipitation and leach operations at the Berkeley Pit and Butte. The main reason for closure can be attributed to poor market conditions.

Montana's State Board of Health and Environmental Sciences has granted a variance of sulfur standards to ASARCO Incorporated for its East Helena smelter. ASARCO is constructing an acid plant, and under its variance the facility would be allowed to emit 15% more sulfur dioxide than State air standards now recommend. Under the variance, the State will conduct a study of the facility to determine if a 90% control level is necessary.

The value of products flowing from Montana mineral processing plants in 1977 was in excess of $1.5 billion. Mineral fuels accounted for 63% of the total, metals accounted for 33%, and nonmetals accounted for 4%.

Montana's processing plants are highly dependent upon out-of-state raw material feed. The aluminum refinery at Columbia Falls is totally dependent upon foreign sources for its alumina. The smelter at East Helena received 50% of its feed from foreign sources, 45% from out-of-state sources, and 5% from Montana sources. Hydrometallurgical and pyrometallurgical plants at Anaconda operated on feed from foreign (15%), out-of-state (45%), and Montana (40%) sources. The copper refinery at Great Falls derived 51% of its input from out-of-state sources. The Stauffer Chemical Co. plant at Silver Bow obtained all of its phosphate rock from Idaho. Throughput at Montana oil refineries was primarily from Canada (43%), Wyoming (38%), and North Dakota (1%).

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels produced (excluding natural gas liquids) during 1977 were valued at $476 million compared with $424 million during 1976, an increase of 12%. Coal production increased 4% compared with that of 1976; natural gas production increased 10%, and petroleum production declined less than 1%.

The value of products from plants processing mineral fuels, that is, electrical generating plants, petroleum refining, and importation of natural gas, was in excess of $1 billion.

Coal.—Output of coal from eastern Montana mines increased about 4% over 1976 production. Montana had eight surface mining operations in 1977, the same as in 1976. Quantity of production ranged from 7,000 tons per year to 10.4 million tons per year. Three mines had a decrease in production and five mines showed an increase in production.

Governor Thomas L. Judge signed an agreement on May 6, 1977, which gave the State of Montana the principal responsibility for administration and enforcement of strip mining on Federal coal leases. The agreement has as one of its objectives the elimination of duplication of enforcement and administration.

Petroleum and Natural Gas.—Crude petroleum recovery declined less than 1% compared with the 1976 figure of 32.8 million barrels. Again as in 1976, the successful secondary program at Bell Creek helped to maintain relative stable production. Gas production in 1977 increased 10% when compared with the production of 1976.

The outlook for future oil and gas development is rated good. Areas of expected play included the Overthrust Belt and shallow Cretaceous sand gas reservoirs of north-central and northwest Montana. In addition, successes in the Williston Basin of eastern Montana have generated continued interest and active exploratory drilling is anticipated.

METALS

The value of metals produced during 1977 decreased 7% compared with the value of production in 1976. In 1977, the value of gold, silver, lead, zinc, tungsten, antimony, and iron ore production increased compared with 1976; however, the value of copper output declined.

The value of products from plants processing metals, that is, copper refining, aluminum refining, lead-silver smelting in 1977, was in excess of $525 million.

Aluminum.—The raw material used in the production of primary aluminum is imported. Value of production of primary aluminum increased by 21% compared with 1976. However, the quantity increased only 6%.

Antimony.—The U.S. Antimony Corp. continued to be one of the largest antimony producers in the United States. Value of production in 1977 was 108% greater than the value of production in 1976. The quantity of production was 9% greater compared with 1976 production.

Copper.—Copper was mined from 13 mines in 6 Montana counties compared with 23 mines in 8 counties during 1976. Copper production decreased 5% in 1977 compared with 1976 production with the value of production decreasing 9%. In excess of 99% of the copper produced came from the open pit operations of The Anaconda Company in Silver Bow County. Based on the value of production, Montana ranked fourth in copper production compared with the other 16 producing States. Montana mines supplied about 6% of the new copper production in the United States in 1977.

The Anaconda Company announced closure of its Arbiter plant at Anaconda and its precipitation and leach operations in Butte. The main reason for closure can be attributed to poor market conditions.

Table 4.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc, in Silver Bow County

Year	Mines producing	Material sold or treated (thousand short tons)	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)
1973	12	19,055	24,341	4,070	132,282	--	--	$170,208
1974	8	23,188	24,609	3,259	131,062	--	--	221,902
1975	6	19,290	13,528	2,162	87,927	12	4	124,647
1976	2	16,803	19,845	2,937	90,909	3	1	141,810
1977	1	15,492	21,181	3,081	85,917	--	--	132,163
1882-1977	--	[1]517,150	2,616,658	673,738	9,262,911	415,442	2,406,823	5,355,620

[1] Complete data not available for 1882-1904.

Table 5.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold	10	3,658	314	1,518	([2])	5	2
Gold-silver	4	3,059	223	20,098	15	69	52
Silver	11	61,178	622	264,052	229	17	23
Total[3]	25	67,895	1,159	285,668	245	91	77
Copper	1	15,475,605	21,181	3,081,451	74,565	--	--
Lead	3	2,012	8	323	--	15	--
Total	4	15,477,617	21,189	3,081,774	74,565	15	1
Other lode material:							
Copper precipitates	2	16,771	--	--	11,393	--	--
Total lode material[3]	29	15,562,283	22,348	3,367,442	86,203	106	79

[1] Detail may not add to total shown because some mines produce more than one class of material.
[2] Less than 1/2 unit.
[3] Data may not add to totals shown because of independent rounding.

Table 6.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by county

County	Mines producing		Material sold or treated[1] (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1975, total	61	2	19,380,426	17,259	$2,787,153	2,616,626	$11,565,486
1976, total	50	2	16,884,241	24,075	3,017,077	3,278,629	14,262,039
1977:							
Broadwater	3	--	102	21	3,115	414	1,913
Granite	5	--	57,182	412	61,103	230,119	1,063,149
Jefferson	4	--	3,281	254	37,670	20,061	92,681

See footnotes at end of table.

Table 6.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by county —Continued

County	Mines producing		Material sold or treated[1] (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1977 —Continued							
Lake	2	--	2,010	28	$4,153	502	$2,319
Lewis and Clark	2	--	77	12	1,780	300	1,386
Madison	6	--	4,445	401	59,472	9,433	43,581
Powell	2	--	82	12	1,779	60	277
Silver Bow	1	--	15,492,299	21,181	3,141,354	3,081,451	14,236,304
Undistributed[2]	4	--	2,805	27	4,004	25,102	115,972
Total	29	--	15,562,283	22,348	3,314,430	3,367,442	15,557,582

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	87,959	$112,939,745	205	$88,328	110	$86,190	$127,466,902
1976, total	91,111	126,826,789	92	42,699	64	47,018	144,195,622
1977:							
Broadwater	(3)	91	2	1,012	(3)	163	6,294
Granite	228	304,362	3	2,032	1	437	1,431,083
Jefferson	15	20,241	69	42,290	52	35,473	228,355
Lake	--	--	2	1,491	1	488	8,451
Lewis and Clark	--	--	2	927	1	962	5,055
Madison	42	55,830	7	4,282	6	4,005	167,170
Powell	--	--	(3)	160	--	--	2,216
Silver Bow	85,917	114,784,860	--	--	--	--	132,162,518
Undistributed[2]	1	1,761	21	12,837	18	12,487	147,061
Total	86,203	115,167,145	106	65,031	79	54,015	134,158,203

[1] Does not include gravel washed.
[2] Beaverhead, Fergus, Judith Basin, and Lincoln Counties combined to avoid disclosing company proprietary data.
[3] Less than 1/2 unit.

Table 7.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation	9	7	--	--	--
Smelting of concentrates from ore	21,710	3,090,673	74,565	14	3
Total	21,719	3,090,680	74,565	14	3
Direct smelting of—					
Ore	629	276,762	245	92	76
Precipitates	--	--	11,393	--	--
Total	629	276,762	11,638	92	76
Total lode	22,348	3,367,442	86,203	106	79

Gold.—Gold was produced principally as a byproduct of copper refining, approximately 95% of the gold mined in the State was associated with the ores from the Berkeley pit operations of Anaconda. Mine production of gold decreased to 22,348 troy ounces, 7% below that of 1976. However, the value of production increased 10%. A total of 24 mines in 10 counties produced gold in 1977 compared with 34 mines in 9 counties in 1976.

Based on value of production, Montana ranks seventh in the production of gold when compared with the other 13 producing States. This ranking is the same as for 1976. Approximately 2% of the gold produced in the United States came from Montana mines.

Construction of a 200-ton-per-day reduction plant to process silver-gold ores near Philipsburg was behind schedule. The plant was to go on-stream in early December.

However, inclement weather resulted in a slowdown. The plant employing a carbon leach process is expected to be completed in early 1978. Future plans call for a ball mill and flotation operation.

A gold heap-leach test in the Little Rockies near Zortman has not progressed as anticipated by the operating company. The necessity to lime wash the 30,000 ton heap to bring the pH to an acceptable level has been time consuming. Subsequently, subzero temperatures invaded the region and the operation has been curtailed.

Iron.—The R & S Iron Co. produced direct shipping ore for the manufacture of cement. The quantity and value of output both increased compared with 1976.

Silver.—The principal source of silver, approximately 91% of the State total, was byproduct output from Anaconda's Berkeley pit in Silver Bow County. Production of silver outside the Butte area decreased about 16% compared with that of 1976. In 1977, the production of silver was from 29 mines in 12 counties compared with production from 47 mines in 15 counties in 1976.

Montana ranked fourth in production of silver based on the value compared with the other 18 producing States. About 9% of the mine-silver production in the United States during 1977 was contributed by Montana mines.

NONMETALS

The value of nonmetals produced during 1977 increased about 20% compared with the value of production during 1976 and represented 11% of the total value of production during 1977. In 1977, the value of production for barite, cement, fluorspar, lime, stone, and sand and gravel was greater than value of production for 1976. The value of products from plants processing nonmetallic minerals was in excess of $53 million.

Clays.—Output of clay and shales in 1977 came from 12 mines in 8 counties, the same as in 1976. The material produced was used for animal feed, face brick, drilling muds, fertilizers, foundry sand, glazing, common brick, paper filler, portland cement, insulation, waterproofing and sealing, iron pellets, concrete blocks, and pottery. There were 10 individuals and/or companies producing clays in Montana. The size of operations ranged from about 16 to about 75,000 tons per year. Based on value, approximately 97% of the production was bentonite. Output from all mines increased 17% compared with that of 1976.

Cement.—Sales of portland cement increased about 4% compared with 1976, and the value of the commodity rose 19%. Masonry cement volume of sales remained about the same; however, the value of sales increased 24%. Two plants, one at Trident, and the other at Montana City, operated in 1977.

Fluorspar.—Production of fluorspar came from one mine. The product was mainly sold as a metallurgical-grade product. Mine production increased significantly with the value of production increasing over 200%.

Gypsum.—United States Gypsum Co. mined and produced gypsum in Fergus County. Crude gypsum production increased 28% with the value of production increasing 31% compared with 1976 figures.

Lime.—The Anaconda Company, Holly Sugar Corp., and Great Western Sugar Co. used lime for metallurgical purposes, sewage treatment, and sugar refining. Production in 1977 was about the same as in 1976. However, the value of the commodity was 29% greater than the value of the commodity produced in 1976.

Phosphate Rock.—Phosphate rock was produced in Powell County. Both the quantity produced and the value decreased during 1977. Compared with statistics for 1976, value decreased 18%, and quantity 15%.

Sand and Gravel.—Sand and gravel produced in 1977 was used for construction and industrial purposes. Based on value, about 94% of the production was used for construction and 6% for industrial uses. Based on volume of material used for construction purposes, 27% was employed as concrete aggregate, about 2% for concrete products, about 9% for asphaltic concretes, about 51% for roadbase and coverings, and about 11% for fill and other uses. The value of construction sand and gravel utilized in 1977 was 33% greater than the value of product in 1976. However, production in 1977 was about 2% less than that in 1976.

Stone.—Livingston Marble and Granite Co., Gardiner Travertine Co., and Frank Jaquette quarried dimension stone at 3 quarries for rough blocks, cut building stone, rubble, rough construction stone, and sawed building stone. Output declined 32% to 2,994 tons valued at $113,600. Fourteen companies crushed stone at 73 quarries for cement, roadstone, lime, and other uses. Output increased 6% to 3.68 million tons valued at $7.92 million. Leading producers were the State Highway Department, Ideal Basic Industries, Inc., and Kaiser Cement & Gypsum Corp.

Sulfur.—Sulfur was recovered as a byproduct from petroleum facilities by two companies operating plants in Yellowstone County. The value and the quantity of sulfur declined for the second straight year.

Talc.—Three companies operating five mines in Madison County produced approximately the same amount of talc in 1977 as in 1976. The value of the product was also approximately equal to the value in 1976. Talc produced in Montana was used in the manufacture of paper, paint, refractories, toilet preparations, rice polishing, ceramics, roofing materials, and insecticides.

Vermiculite.—W. R. Grace & Co. produced vermiculite from its mine in Lincoln County, primarily for further treatment and sales outside of Montana. Production increased about 16% compared with 1976 production with the value increasing about 30%.

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[1] State Liaison Officer, Bureau of Mines, Helena, Mont.

[2] Staff Field Agent, Montana Bureau of Mines and Geology.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum: Anaconda Aluminum Co	Columbia Falls, MT 59912	Plant	Flathead.
Antimony: U.S. Antimony Corp	Box 643 Thompson Falls, MT 59873	Mine and plant	Sanders.
Barite: Montana Barite Co	Box 3296 Missoula, MT 59801	do	Missoula.
Cement:			
Ideal Cement Co.[1]	821 17th St. Denver, CO 80202	Plant	Gallatin.
Kaiser Cement and Gypsum Corp.[1]	300 Lakeside Dr. Oakland, CA 94604	do	Jefferson.
Clays:			
American Colloid Co	5100 Suffield Ct. Skokie, IL 60067	Pit	Carbon.
Hallett Minerals Co	Box 491 Forsyth, MT 59327	Plant and pit	Treasure.
International Minerals and Chemical Corp.	Old Orchard Rd. Skokie, IL 60076	Pit	Carter.
NL Industries, Inc	Box 1675 Houston, TX 77001	Pit	Do.
Coal:			
Decker Coal Co	Box 12 Decker, MT 59025	Strip mine	Big Horn.
Knife River Coal Co	Box 37 Savage, MT 59262	do	Richland.
Peabody Coal Co	Big Sky Mine Colstrip, MT 59232	do	Rosebud.
Western Energy Co	40 East Broadway Butte, MT 59701	do	Do.
Westmoreland Resources	823 West 3d Hardin, MT 59034	do	Big Horn.
Copper: The Anaconda Company[2]	Anaconda, MT 59711	Smelter, mine and plant	Silver Bow.
Fluorspar: Roberts Mining Co	Box 356 Darby, Mt 59829	Mine and plant	Ravalli.
Gypsum: United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	Underground mine and plant.	Fergus.
Iron ore: R & S Iron Co	Radersburg, MT 59644	Mine	Meagher.
Petroleum:			
Big West Oil Co. of Montana	Kevin, MT 59644	Refinery	Toole.
Continental Oil Co	Billings, MT 59101	do	Yellowstone.
Exxon Corp	do	do	Do.
Farmer's Union Central Exchange, Inc.	Lauree, MT 59044	do	Do.
Phillips Petroleum Co	Great Falls, MT 59401	do	Cascade.
Tesora Petroleum Co	8700 Tesora Dr. San Antonio, TX 78217	do	Roosevelt.
Westco Refining Co	Box 318 Cut Bank, MT 59427	do	Glacier.
Phosphate rock:			
Cominco American, Inc	Garrison, MT 59731	Mine	Powell.
Stauffer Chemical Co.[3]	229 Park Ave. New York, NY 10017	Plant	Silver Bow.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Gallatin Sand & Gravel Co	Box 248 Bozeman, MT 59715	Pit	Gallatin.
McElroy & Wilkin Inc	Box 35 Kalispell, MT 59901	Pit	Flathead.
Midland Materials Co	Box 2521 Billings, MT 59103	Pit	Yellowstone.
Barry O'Leary Co	Box 1102 Billings, MT 59103	Pit	Do.
M.S. Ready Mix	Box 1501 Missoula, MT 59801	Pit	Missoula.
Silver: Black Pine Mining Co	Box 610 Philipsburg, MT 59858	Mine and plant	Granite.
Stone: Big Horn Calcium Co	Box 118 Frannie, WY 82423	Quarry	Carbon and Granite.
Sulfur: Montana Sulphur Co	Billings, MT 59101	Plant	Yellowstone.
Talc:			
Cyprus Industrial Minerals Co	555 South Flower St. Los Angeles, CA 90017	Open pit and plant	Madison.
Pfizer Co., Inc	Box 1147 Dillon, MT 59725	do	Do.
Vermiculite, crude: W.R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Lincoln.

[1] Also clays and stone.
[2] Also aluminum, gold, lime, silver, and stone.
[3] Also stone.

The Mineral Industry of Nebraska

This chapter has been prepared under a memorandum of understanding between the Bureau of Mines, U.S. Department of the Interior, and the Conservation and Survey Division of the University of Nebraska, Nebraska Geological Survey, for collecting information on all minerals except fuels.

By Robert B. McDougal[1] and Raymond R. Burchett[2]

Nebraska's mineral production was valued at a record high $144.0 million in 1977, an increase of $20.7 million or 16.8% compared with the production value of 1976. Petroleum and natural gas comprised 45% of the mineral production value in 1977, compared with 46% the previous year. Sand and gravel and stone contributed 30% of the State's total value compared with 26% in 1976. Cement, clays, gem stones, lime, and natural gas liquids accounted for the remaining 25% of Nebraska's mineral production value in 1977.

One new sandstone quarry opened in 1977, but 5 limestone quarries were closed, and there were 11 fewer sand, gravel, and silt pits. During 1977, there were active in Nebraska 37 limestone quarries, 585 sand, gravel, and silt pits, 8 clay or shale pits, 21 sandstone pits, and 1 peat pit. These 652 mining operations disturbed 1,372 acres, and 493 acres were restored during the year. Nebraska's mining operations during the past 50 years were inventoried in the report.[3]

Table 1.—Mineral production in Nebraska[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---- thousand short tons	149	$345	161	$368
Gem stones	NA	11	NA	11
Natural gas ---- million cubic feet	2,511	1,288	2,789	1,818
Petroleum (crude) ---- thousand 42-gallon barrels	6,182	55,551	5,968	62,425
Sand and gravel[2] ---- thousand short tons	14,230	21,483	16,848	30,566
Stone ---- do	4,101	11,054	4,128	12,974
Combined value of cement (masonry and portland), lime, natural gas liquids, and sand and gravel (industrial)	XX	33,633	XX	35,867
Total	XX	123,365	XX	144,029
Total 1967 constant dollars	XX	44,350	XX	[p]71,093

[p]Preliminary. NA Not available. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes industrial sand and gravel; value included with "Combined value" figure.

Table 2.—Value of mineral production in Nebraska, by county[1][2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	W	--	
Antelope	$118	$400	Sand and gravel.
Banner	6,987	218	Do.
Boone	W	--	
Box Butte	12	--	
Boyd	59	--	
Brown	W	W	Sand and gravel.
Buffalo	748	1,722	Do.
Burt	9	W	Do.
Butler	457	556	Do.
Cass	W	W	Cement, stone, sand and gravel, clays.
Cedar	189	412	Sand and gravel.
Chase	48	178	Do.
Cherry	W	W	Do.
Cheyenne	14,543	55	Do.
Clay	W	W	Do.
Colfax	318	W	Do.
Cuming	735	823	Do.
Custer	225	265	Do.
Dawes	W	--	
Dawson	942	1,125	Sand and gravel.
Deuel	40	W	Do.
Dixon	W	W	Sand and gravel, stone.
Dodge	553	1,165	Sand and gravel.
Douglas	W	W	Sand and gravel, clays.
Dundy	W	267	Sand and gravel.
Fillmore	W	W	Do.
Franklin	197	1,006	Do.
Frontier	W	W	Do.
Furnas	W	185	Do.
Gage	791	1,187	Sand and gravel, stone.
Garden	W	97	Sand and gravel.
Garfield	24	24	Do.
Grant	3	--	
Greeley	W	W	Sand and gravel.
Hall	769	1,429	Do.
Hamilton	242	313	Do.
Harlan	W	NA	
Hayes	W	W	Sand and gravel.
Hitchcock	W	W	Do.
Holt	522	556	Do.
Hooker	W	8	Do.
Howard	W	235	Sand and gravel.
Jefferson	W	W	Sand and gravel, clays.
Kearney	44	84	Sand and gravel.
Keith	205	170	Do.
Kimball	11,421	5	Do.
Knox	133	221	Do.
Lancaster	483	W	Stone, sand and gravel, clays.
Lincoln	W	725	Sand and gravel.
Loup	W	9	Do.
Madison	759	1,218	Do.
Merrick	287	452	Do.
Morrill	3,341	W	Sand and gravel, lime.
Nance	166	403	Sand and gravel.
Nemaha	W	W	Stone, sand and gravel.
Nuckolls	W	W	Cement, sand and gravel, stone.
Otoe	--	W	Stone.
Pawnee	W	W	Do.
Perkins	W	--	
Phelps	W	58	Sand and gravel.
Pierce	142	448	Do.
Platte	957	1,212	Do.
Polk	W	W	Do.
Red Willow	W	170	Do.
Richardson	W	W	Stone, sand and gravel.
Rock	6	6	Sand and gravel.
Saline	W	165	Do.
Sarpy	W	W	Stone, sand and gravel, clays.
Saunders	W	W	Sand and gravel, stone.
Scotts Bluff	3,124	W	Sand and gravel, lime.
Seward	56	30	Stone.
Sheridan	W	280	Sand and gravel.
Stanton	W	438	Do.
Thayer	222	510	Do.
Thomas	121	W	Do.
Valley	W	33	Do.

See footnotes at end of table.

Table 2.—Value of mineral production in Nebraska, by county[1][2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Washington	W	W	Stone.
Webster	148	320	Sand and gravel.
York	101	W	Do.
Undistributed[3]	73,120	124,843	
Total[4]	123,365	144,029	

NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Arthur, Blaine, Dakota, Gosper, Johnson, Keya Paha, Logan, McPherson, Sherman, Sioux, Thurston, Wayne, and Wheeler.

[2] Value of petroleum and natural gas are based on the average price per barrel and cubic foot, respectively, for the State.

[3] Includes gem stones, sand and gravel, natural gas, natural gas liquids, and petroleum that cannot be assigned to specific counties and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Nebraska business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ... thousands	718.0	752.0	+4.7
Unemployment ... do	24.0	28.0	+1.7
Employment (nonagricultural):			
Mining ... do	1.7	1.6	-5.9
Manufacturing ... do	87.9	90.6	+3.1
Contract construction ... do	30.0	31.9	+6.3
Transportation and public utilities ... do	40.6	42.0	+3.4
Wholesale and retail trade ... do	150.9	153.9	+2.0
Finance, insurance, real estate ... do	35.7	37.8	+5.9
Services ... do	101.0	101.4	+.4
Government ... do	124.3	126.6	+1.8
Total nonagricultural employment ... do	572.1	585.8	+2.4
Personal income:			
Total ... millions	$9,486	$10,491	+10.6
Per capita	$6,112	$6,720	+9.9
Construction activity:			
Number of private and public residential units authorized	10,528	11,322	+7.5
Value of nonresidential construction ... millions	$108.1	$106.4	-1.6
Value of State road contract awards ... do	69.0	70.0	+1.4
Shipments of portland and masonry cement to and within the State ... thousand short tons	1,047	1,022	-2.4
Mineral production value:			
Total crude mineral value ... millions	$123.4	$144.0	+16.7
Value per capita, resident population	$79	$92	+16.5
Value per square mile	$1,597	$1,865	+16.8

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and Federal Bureau of Mines.

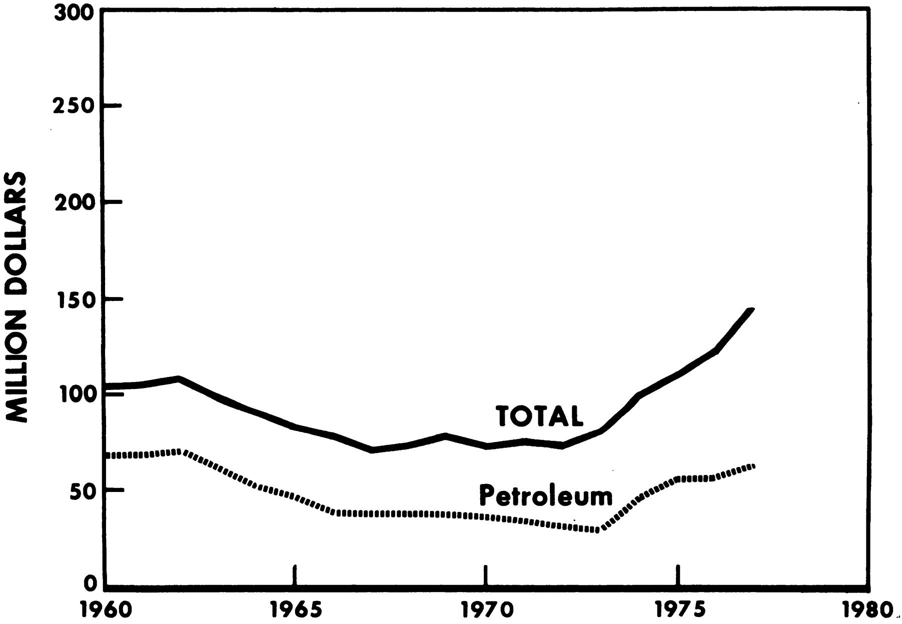

Figure 1.—Value of petroleum and total value of mineral production in Nebraska.

Legislation and Government Programs.—The Nebraska Geological Survey was engaged in geologic and other investigations concerning the State's mineral potential, mineral-related industrial development, and the relationship between mineral development and other land uses. The Conservation and Survey Division continued its long-range field mapping of quadrangle maps showing consolidated bedrock, bedrock exposures, and the thickness of unconsolidated mantlerock through the use of a combination of patterns and colors at a scale of 1:250,000, or approximately one-quarter inch to the mile. Field mapping was in progress for the Sioux City, McCook, North Platte, and Scotts Bluff quadrangles.

A test drilling program conducted jointly by the Conservation and Survey Division and the U.S. Geological Survey for groundwater studies in western Nebraska created interest by private industry in uranium exploration. A detailed study of ground magnetics and gravity in eastern Nebraska was utilized to study not only structural relationships but also the potential occurrence of metallic minerals. A continuing soil mapping program, in cooperation with the Soil Conservation Service, U.S. Department of Agriculture, proved useful in prospecting for sand and gravel deposits.

A report on coal in Nebraska was published.[4]

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement manufacturing contributed significantly to Nebraska's mineral production value in 1977. Output of portland cement declined whereas masonry cement production increased slightly compared with that of 1976. Despite a drop in the unit value of masonry cement, the overall value of cement rose nearly 5% as a result of an increase in the unit value of portland cement. Cement was produced by Ash Grove Cement Co. in Cass County and by Ideal Basic Industries, Inc., in Nuckolls County. Limestone, common clay and shale, and gypsum were the principal raw materials used to manufacture cement. Disposition of cement, in descending order of use, was ready-mixed concrete, highway contractors, concrete products manufacturers, building materials dealers, other contractors, and miscellaneous users. Distribution of shipments was about two-thirds by truck and one-third by rail.

Clays.—Four firms produced clay in 1977. Clay production increased 8% in tonnage and 7% in value over that of 1976. Ash Grove Cement Co. produced clay for cement manufacture near Louisville, Cass County. Endicott Clay Products Co. produced clay for face brick at Endicott, Jefferson County. Omaha Brick Works produced clay for common and face brick near Ralston, Douglas County, and in Sarpy County. Yankee Hill Brick Manufacturing Co. produced clay for common and face brick near Lincoln, Lancaster County.

Fertilizer Materials.—Producers of ammonia, urea, and ammonium nitrate included Allied Chemical Co. at La Platte in Sarpy County; C. F. Industries, Inc., at Fremont in Dodge County; and Phillips Chemical Co. at Beatrice in Gage County. At Hastings in Adams County, Farmland Industries, Inc., produced ammonia. Cominco-American, Inc., produced ammonium nitrate at Beatrice.

Lime.—Great Western Sugar Co. produced lime from limestone shipped from its quarry in Wyoming. Limekilns were located at Scottsbluff, Gering, and Mitchell in Scotts Bluff County, and at Bayard in Morrill County. Output and value of production, used mainly for sugar refining, increased over those of 1976.

Perlite.—The perlite plant of the Zonolite Division, W. R. Grace & Co. near Omaha, Douglas County, was inactive in 1977. No future production at the plant is planned by the company.

Sand and Gravel.—Nebraska produced about 18% more construction sand and gravel in 1977 than in 1976. Production was 16.8 million tons valued at $30.6 million, compared with 14.2 million tons valued at $21.5 million in 1976. Average value of sand and gravel in 1977 was $1.81 per ton, compared with $1.51 in 1976.

Sand and gravel was produced in 68 counties by 198 companies and government organizations at 254 operations. Forty companies with individual output of more than 100,000 tons accounted for 77% of the total sand and gravel production by quantity and

79% by value. Principal producers were Lyman-Richey Sand & Gravel Corp. with operations in Cass, Dodge, Douglas, Morrill, Platte, and Saunders Counties; Western Sand & Gravel Co. in Cass, Dodge, and Saunders Counties; Hartford Sand & Gravel Co. in Dodge and Douglas Counties; and Central Sand & Gravel Co. in Butler, Hall, Madison, and Platte Counties. Together, their 23 operations accounted for 28% of the State's output by quantity and 30% by value. Douglas, Saunders, and Buffalo Counties were the leading producing counties.

Of the total production sold or used in 1977, commercial producers accounted for nearly 79% of the quantity and 78% of the value. Government and contractor operations provided the remainder. The combined major uses, by quantity, were for roadbase and concrete aggregate (each 29%), asphaltic concrete aggregate (20%), fill (15%), and other (7%).

Table 4.—Nebraska: Construction sand and gravel sold or used by producers, by county[1]

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams	1	W	W	--	--	--
Antelope	3	75	118	3	233	400
Banner	2	W	W	2	145	218
Boone	1	W	W	--	--	--
Boyd	1	37	59	--	--	--
Brown	3	W	W	3	W	W
Buffalo	8	720	748	9	1,011	1,722
Burt	1	37	9	1	W	W
Butler	4	247	457	4	328	556
Cass	4	863	1,421	4	778	1,384
Cedar	3	109	189	3	231	412
Chase	4	81	48	4	114	178
Cherry	1	W	W	1	W	W
Cheyenne	5	W	W	1	40	55
Clay	3	W	W	3	W	W
Colfax	3	161	318	2	W	W
Cuming	4	465	735	4	467	823
Custer	4	138	225	4	146	265
Dawes	1	W	W	--	--	--
Dawson	5	710	942	5	649	1,125
Deuel	2	W	40	2	W	W
Dixon	1	W	W	1	W	W
Dodge	5	297	553	5	517	1,165
Douglas	8	1,729	3,085	6	1,908	3,811
Dundy	1	W	W	2	153	267
Fillmore	1	W	W	1	W	W
Franklin	4	114	197	4	585	1,006
Frontier	2	W	W	2	W	W
Furnas	3	91	141	4	112	185
Gage	7	211	580	9	281	985
Garden	3	46	17	3	65	97
Garfield	1	16	24	1	16	24
Grant	1	12	3	--	--	--
Greeley	2	W	W	2	W	W
Hall	12	676	769	15	893	1,429
Hamilton	4	192	242	4	180	313
Hayes	1	W	W	1	W	W
Hitchcock	2	15	24	2	W	W
Holt	13	408	522	11	328	556
Hooker	1	W	W	1	5	8
Howard	3	W	W	2	139	235
Jefferson	4	W	W	4	W	W
Kearney	1	47	44	1	47	84
Keith	4	231	205	3	102	170
Kimball	4	4	1	4	4	5
Knox	6	93	133	6	137	221
Lancaster	1	W	W	1	W	W
Lincoln	10	803	736	9	479	725
Loup	2	W	W	2	6	9
Madison	7	526	759	7	688	1,218
Merrick	7	232	287	8	278	452
Morrill	6	137	235	6	228	423
Nance	4	114	166	4	236	403
Nemaha	--	--	--	1	6	21
Nuckolls	3	92	217	3	214	320
Perkins	2	W	W	--	--	--

See footnotes at end of table.

Table 4.—Nebraska: Construction sand and gravel sold or used by producers, by county[1] —Continued

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Phelps	2	W	W	2	39	58
Pierce	3	77	142	3	249	448
Platte	6	492	957	7	640	1,212
Polk	3	W	W	3	W	W
Red Willow	7	112	224	5	127	170
Richardson	2	W	W	3	36	54
Rock	1	4	6	1	4	6
Saline	3	W	W	3	69	165
Sarpy	2	W	W	2	W	W
Saunders	5	1,141	2,164	5	1,222	2,218
Scotts Bluff	7	551	735	9	654	1,086
Sheridan	3	53	102	3	125	280
Stanton	2	W	W	2	250	438
Thayer	5	130	222	4	273	510
Thomas	1	82	121	1	W	W
Valley	2	W	W	3	22	33
Webster	5	91	148	6	197	320
York	1	W	101	1	W	W
Undistributed	--	1,764	2,817	--	1,197	2,296
Total[2]	259	14,230	21,483	254	16,848	30,566

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Excludes industrial sand and gravel.

[2] Data may not add to totals shown because of independent rounding.

Table 5.—Nebraska: Construction sand and gravel[1] sold or used by producers

(Thousand short tons and thousand dollars)

	1976		1977	
	Quantity	Value	Quantity	Value
Sand	5,093	6,445	6,043	10,842
Gravel	9,136	15,038	10,805	19,724
Total	[2]14,230	21,483	16,848	30,566

[1] Includes both unprocessed and processed sand and gravel.

[2] Data do not add to total shown because of independent rounding.

Table 6.—Nebraska: Construction sand and gravel[1] sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	5,131	8,420	4,804	9,445
Concrete products	1,414	2,321	984	2,282
Asphaltic concrete aggregate	1,779	2,935	3,331	6,459
Roadbase and coverings	3,793	5,523	4,955	8,975
Fill	1,886	2,076	2,606	3,123
Other	225	208	167	281
Total[2]	14,230	21,483	16,848	30,566

[1] Includes both unprocessed and processed sand and gravel.

[2] Data may not add to totals shown because of independent rounding.

Stone.—Limestone was the only stone produced in Nebraska; crushed and broken stone was produced at 26 quarries by 16 companies in 13 counties. Output was about the same in quantity and 17% higher in value than in 1976. Unit value increased from $2.70 per ton in 1976 to $3.14 per ton in 1977. Leading stone producers were Hopper Brothers Quarries, Ash Grove Cement Co., and Kerford Limestone Co.

Table 7.—Nebraska: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976 Quantity	1976 Value	1977 Quantity	1977 Value
Concrete aggregate	1,244	3,548	W	W
Cement manufacture	1,067	W	W	W
Surface treatment aggregate	480	1,340	W	W
Roadstone	323	1,069	W	W
Agricultural limestone	259	636	196	509
Dense-graded roadbase stone	174	401	W	W
Riprap and jetty stone	214	803	68	195
Asphalt filler	W	W	W	W
Flux stone	--	--	W	W
Other uses[1]	340	3,258	3,864	12,270
Total	4,101	[2]11,054	4,128	12,974

W Withheld to avoid disclosing company proprietary data; included with "Other uses."
[1] Includes stone used in bituminous aggregate, mineral food, waste material, railroad ballast, filter stone, and uses indicated by symbol W.
[2] Data do not add to total shown because of independent rounding.

Vermiculite.—Construction Products Div., W. R. Grace and Co., produced exfoliated vermiculite at its plant near Omaha, Douglas County. The crude vermiculite was imported from the firm's mine in Montana. Major uses for the expanded product were insulation, concrete aggregate, and fireproofing.

METALS

The Omaha refinery of ASARCO, Inc., processed lead bullion received from smelters throughout the United States. Antimony, bismuth oxide, doré containing silver and gold, copper, and zinc were recovered. In 1977, the Omaha refinery produced 110,000 tons of refined lead, which is less than usual owing to the nationwide copper strike.

MINERAL FUELS

The Nebraska Oil and Gas Conservation Commission issued 507 permits to drill for oil and gas in 1977. Of these permits, 267 were for exploration in 22 counties, principally in Cheyenne (47), Kimball (42), and Banner (41); 237 were for development in 11 counties, mostly in Hitchcock (65), Cheyenne (48), and Kimball (43); and 3 were water disposal wells in Deuel County (2) and Kimball County. At yearend 1977, there were 1,400 active oil and gas wells in Nebraska and 393 capped wells. Of the total active oil wells, 1,230 were in Red Willow, Kimball, Cheyenne, Banner, and Hitchcock Counties.

Natural gas production totaled 2,789 million cubic feet valued at $1.8 million in 1977, compared with 2,511 million cubic feet valued at $1.3 million a year earlier. Average wellhead value rose from 51.3 cents per thousand cubic feet to 65.2 cents per thousand in 1977. According to the Oil and Gas Conservation Commission, 2,793 million cubic feet was produced in Nebraska in 1977, of which 2,178 million cubic feet was casinghead gas produced in seven counties, mainly Cheyenne (79%) and Kimball (12%) Counties, and the remainder dry gas produced principally from Cheyenne (86%) and Kimball (12%) Counties.

Almost 6 million barrels of crude petroleum valued at $62.4 million was produced from 1,382 oil wells located in 15 counties in 1977, compared with 6.2 million barrels valued at $55.6 million produced from 1,291 oil wells in 14 counties the previous year. The number of capped oil wells dropped from 390 in 1976 to 383 in 1977. Average unit value per barrel rose from $8.99 in 1976 to $10.46. Nebraska's largest petroleum-producing field, Sleepy Hollow in Red Willow County, produced 15.7% of the total.

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[1] State Liaison Officer, Bureau of Mines, Topeka, Kans.
[2] Research geologist, Nebraska Geological Survey, Lincoln, Nebr.
[3] Burchett, R. R., and D. A. Eversoll. Nebraska Mineral Operations Review, 1977. Nebr. Geol. Survey Open File Rept., 1978, 12 pp.
[4] Burchett, R. R. Coal Resources in Nebraska. Univ. Nebr. Conservation and Survey Div., Nebr. Geol. Survey Res. Rept. 7, 1977, 198 pp.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co.[1]	1000 Tenmain Center Kansas City, MO 64105	Plant	Cass.
Ideal Basic Industries, Inc.[2]	420 Ideal Cement Bldg. Denver, CO 80202	do	Nuckolls.
Clays:			
Endicott Clay Products Co	Box 17 Fairbury, NE 68352	Open pit and plant	Jefferson.
Yankee Hill Brick Manufacturing Co	Route 1 Lincoln, NE 68502	do	Lancaster.
Lime:			
Great Western Sugar Co	Box 5038 Denver, CO 80217	Plants	Morrill and Scotts Bluff.
Sand and gravel:			
Behrens Construction Co	Box 188 Beatrice, NE 68310	Pits and plants	Gage and Saline.
Central Sand & Gravel Co	Box 626 Columbus, NE 68601	do	Butler, Hall, Madison, Platte.
Elkhorn Construction Co	Box 168 Norfolk, NE 68701	do	Madison.
Hartford Sand & Gravel Co	Box Z Valley, NE 68064	Dreding and pits	Dodge and Douglas.
Kirkpatrick Sand & Gravel Co	Box 6 Lexington, NE 68850	Pit and plant	Dawson.
Luther & Maddox Gravel Co	3000 S. Blaine St. Grand Island, NE 68801	Pits and plants	Hall.
Lyman-Richey Sand & Gravel Corp	4315 Cuming St. Omaha, NE 68161	do	Cass, Douglas, Morrill, Platte, Saunders.
Olson Sand & Gravel Co	Alma, NE 68920	Pit	Franklin.
Overland Sand & Gravel Co	Box 307 Stromsberg, NE 68666	Pits and plants	Hamilton, Merrick, Nance, Polk.
Sawyer Sand & Gravel Co	207 South East Ave. Holdredge, NE 68949	Pits	Buffalo and Phelps.
Western Sand & Gravel Co	Box 80268 Lincoln, NE 68501	Pits and plants	Cass, Dodge, Saunders.
Stone:			
City Wide Rock & Excavation Co	3863 Mason St. Omaha, NE 68105	Quarries and plants	Sarpy.
Fort Calhoun Stone Co	1255 South St. Blair, NE 68008	do	Washington.
Hopper Brothers Quarries	Box 383 Weeping Water, NE 68463	do	Cass, Gage, Nemaha, Nuckolls, Otoe, Pawnee, Richardson, Saunders.
Kerford Limestone Co	Box 434 Weeping Water, NE 68463	Quarry and plant	Cass.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Douglas.

[1] Also clays and stone.
[2] Also stone.

The Mineral Industry of Nevada

This chapter was prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Nevada Bureau of Mines and Geology for collecting information on all minerals.

By Paul V. Fillo[1] and Susan G. Dietrich[2]

The value of output from Nevada's mineral industry rose to a record $270.8 million in 1977. Of the 26 mineral commodities produced, 9 were metals, and 16 were nonmetals, and petroleum was the sole fuel commodity.

The production value of the State's metals—considered as a group—increased 18% over the previous year's value, nonmetals increased 8% in value, and the value of petroleum increased 374%. Copper production value, which accounted for 34% of the State's total mineral production value, increased 11% over 1976 production. Gold, lead, molybdenum, and tungsten showed substantial increases in production. There was increased production of all metals from 1976 to 1977, except for silver; silver production decreased 6%. In the nonmetals group, production of fluorspar, stone, cement, and lime showed declines from 1976 levels, but for each of the State's other nonmetals, total production increased from 1976 to 1977.

Consumption, Trade, and Markets.—Except for construction materials, all of Nevada's requirements for mineral fuels and metals—and most of its nonmetal needs—were supplied by out-of-State processors.

Most of the State's lime output was sold to consumers in California, although some was used in Nevada. All of the fluorspar, a third of the barite production, and some of the gypsum and limestone produced were shipped out of State in crude form. Most of Nevada's petroleum production was consigned to refineries in Utah and California. Nevada producers of tungsten concentrates shipped most of their output to Union Carbide Corp.'s ammonium paratungstate plant at Pine Creek near Bishop, Calif. Tungsten carbide was produced in Nevada in substantial quantities by Kennametal, Inc., near Fallon, using a unique thermit process that produces macrocrystalline tungsten carbide directly from tungsten concentrates.

Trends and Developments.—A dispute continued between the Environmental Protection Agency (EPA) and the Kennecott Copper Corp. over compliance with the Federal Clean Air Act of 1977. It is EPA's position that Kennecott should comply with the Clean Air Act, but Kennecott, with support from the State, is seeking permission to abide only under provisions of the Nevada Implementation Plan. At issue is the installation of costly pollution control equipment by Kennecott, as would be required under the Clean Air Act.

A district court injunction that blocked EPA's efforts to bring Kennecott under compliance was overturned by the Ninth Circuit Court of Appeals. Then the U.S. House-Senate conference committee on the Clean Air Act unanimously approved the so-called "Ely Amendment," allowing Kennecott to continue operating for two 5-year periods without installation of the pollution control equipment required by the Clear Air Act. At yearend, the Nevada Environmental Protection Services, which sides with Kennecott on this issue, was deadlocked with EPA over a decision by the State to place Kennecott in a special category for meeting Federal air quality regulations.

The depressed copper market had a serious effect on the State's copper industry. The Anaconda Company's Victoria mine in Elko County closed in September, idling 150 workers. The company announced its Weed Heights operations in Lyon County would close in 1981, but later announced a mid-1978 date for closing because of continued low copper prices. In September, Kennecott Copper cut back two of its operations in White Pine County. Concentrator operations at McGill and mining operations at Ruth were cut back, resulting in a layoff of employees and reduced production.

Oil production from the Trap Springs field, adjacent to the Eagle Springs field, increased substantially since the field was discovered in October 1976. Producers at Trap Springs were faced with a marketing problem during the year due to a lack of refinery capacity in Salt Lake City, Utah and Bakersfield, Calif., where the oil is trucked. Nevada has only one small refinery; it is located near the Tonopah airport in Nye County. The possibility of constructing a refinery near Ely in White County was discussed during the year, but little progress was made toward this project by the end of the year.

New mining operations in Nevada continued to expand, with several mining companies conducting exploratory work. It was estimated that over $20 million was spent to evaluate deposits of gold, silver, lead, zinc, molybdenum, tungsten, and barite during the year, and exploratory drilling totaled more than one-half million feet.

Freeport Exploration Co. and FMC Corp. engaged in a joint venture that involved extensive prospecting and drilling for gold in the Jerritt Canyon area of the Independence Mountains in Elko County. Their work was carried out on a newly-discovered gold deposit that could possibly develop into one of Nevada's largest gold operations.

In March, the Smoky Valley Mining Co. started operations at its gold mine at Round Mountain in Nye County. Smoky Valley expects the gold output there to range from 6,000 to 7,000 ounces per month, and is using a process known as heap leaching and activated carbon extraction.

Scurry-Rainbow Oil Ltd. acquired the Gooseberry mine, a gold and silver property near Reno. After extensive underground exploration, a 350-ton-per-day mill and other surface installations were constructed. The property was in full production for the last part of the year.

Duval Corp. began construction in the fall of a $6 million solvent extraction-electrowinning plant at its Copper Basin site near Battle Mountain in Lander County. Duval expects to complete construction by the third quarter of 1978.

Three new barite-processing facilities representing a capital investment of more than $7.7 million were dedicated in the spring by IMCO Services, a division of Halliburton Co. In June, Union Carbide dedicated a $31 million tungsten mining and milling facility at Tempiute in northwest Lincoln County, about 50 miles northwest of Alamo. The new facility, known as the Emerson tungsten mine and mill, is capable of producing 2 million pounds of tungsten ore concentrates per year and can process 1,000 tons of ore per day. Union Carbide estimates that reserves at the Emerson mine will provide the new mill with enough tungsten ore to last for more than 20 years.

Table 1.—Mineral production in Nevada[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite ---------- thousand short tons--	900	$18,379	1,158	$18,329
Clays[2] ---------- do----	7	174	10	158
Copper (recoverable content of ores, etc.) -------- short tons--	58,160	80,958	67,061	89,593
Gem stones ----------	NA	1,300	NA	1,000
Gold (recoverable content of ores, etc.) -------- troy ounces--	287,962	36,087	324,003	48,058
Gypsum ---------- thousand short tons--	792	3,884	1,242	6,834
Lead (recoverable content of ores, etc.) -------- short tons--	582	269	743	456
Mercury ---------- 76-pound flasks--	22,837	2,770	W	W

See footnotes at end of table.

Table 1.—Mineral production in Nevada[1] —Continued

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Petroleum (crude) ---------- thousand 42-gallon barrels--	143	W	W	W
Pumice ------------------ thousand short tons--	388	763	656	1,154
Sand and gravel ------------------------do----	9,671	20,106	10,185	21,172
Silver (recoverable content of ores, etc.) thousand troy ounces--	784	3,410	738	3,411
Stone -------------------- thousand short tons--	[3]1,904	[3]5,975	1,668	5,506
Tungsten (W content) ------------ thousand pounds--	99	561	263	1,687
Zinc (recoverable content of ores, etc.)---------short tons--	1,438	1,064	1,672	1,150
Combined value of cement (portland), clays (common clay, fuller's earth, kaolin), diatomite, fluorspar, iron ore, lime, lithium compounds, magnesite, molybdenum, perlite, salt, talc and items indicated by symbol W------------	XX	57,983	XX	72,342
Total --------------------------------	XX	233,683	XX	270,845
Total 1967 constant dollars ------------------	XX	84,009	XX	[p]133,689

[p] Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes common clay, fuller's earth and kaolin; value included in "Combined value" figure.

[3] Excludes dimension stone; value included in "Combined value" figure.

Table 2.—Value of mineral production in Nevada, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Carson City ------------	$393	$358	Pumice, sand and gravel, stone.
Churchill -------------	1,091	1,460	Diatomite, sand and gravel, tungsten, salt, pumice, stone, silver, lead.
Clark ---------------	25,527	32,453	Sand and gravel, lime, gypsum, stone, clays, gold, silver.
Douglas --------------	586	W	Sand and gravel, stone, tungsten, silver.
Elko ----------------	W	13,084	Gold, copper, barite, tungsten, silver, sand and gravel, lead, zinc.
Esmeralda ------------	12,441	12,556	Lithium, diatomite, sand and gravel, talc, clays, tungsten.
Eureka --------------	25,637	W	Gold, iron ore, stone, silver, mercury, lead, zinc, copper.
Humboldt -------------	3,824	4,344	Mercury, stone, sand and gravel, clays.
Lander --------------	41,255	32,700	Barite, copper, gold, silver, sand and gravel, lead.
Lincoln --------------	3,988	5,478	Gold, zinc, tungsten, silver, lead, sand and gravel, perlite, clays, copper.
Lyon ----------------	63,606	58,034	Copper, cement, stone, sand and gravel, gypsum.
Mineral --------------	20	56	Sand and gravel, tungsten, stone.
Nye -----------------	7,294	11,464	Gold, barite, magnesite, sand and gravel, clays, fluorspar, pumice, silver, tungsten.
Pershing -------------	5,471	13,711	Diatomite, gypsum, copper, iron ore, sand and gravel, tungsten, perlite, clays, stone.
Storey ---------------	W	6,168	Diatomite, silver, gold, sand and gravel, pumice.
Washoe --------------	W	W	Sand and gravel, pumice, clays, stone, tungsten.
White Pine ------------	W	W	Copper, gold, molybdenum, silver, tungsten, sand and gravel.
Undistributed[1] ----------	42,549	78,981	
Total[2] ------------	233,683	270,845	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes some sand and gravel that cannot be assigned to specific counties; and gem stones and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Nevada business activity

	1976	1977[p]	Change (percent)
Employment and labor force, annual average:			
Total civilian labor force ____ thousands__	306.0	321.0	+4.9
Unemployment ____ do____	27.0	23.0	-14.8
Employment (nonagricultural):			
Mining ____ do____	3.7	4.2	+13.5
Manufacturing ____ do____	13.0	15.0	+15.4
Contract construction ____ do____	14.8	19.4	+31.1
Transportation and public utilities ____ do____	17.6	18.7	+6.2
Wholesale and retail trade ____ do____	56.5	61.0	+8.0
Finance, insurance, real estate ____ do____	11.4	12.7	+11.4
Services ____ do____	116.0	127.2	+10.0
Government ____ do____	46.8	49.2	+5.1
Total nonagricultural employment ____ do____	279.8	307.4	+9.9
Personal income:			
Total ____ millions__	$4,410	$5,059	+14.7
Per capita ____	$7,198	$7,988	+11.0
Construction activity:			
Number of private and public residential units authorized ____	13,606	20,396	+49.9
Value of nonresidential construction ____ millions__	$140.7	$247.4	+75.8
Value of State road contract awards ____ do____	$52.0	$56.0	+7.7
Shipments of portland and masonry cement to and within the State thousand short tons__	359	511	+42.3
Mineral production value:			
Total crude mineral value ____ millions__	$233.7	$270.8	+15.9
Value per capita, resident population ____	$383	$428	+11.7
Value per square mile ____	$2,114	$2,450	+15.9

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Legislation and Government Programs.—The State of Nevada received $9.7 million in revenues from the Federal government in 1977 as its share of four Federal programs participated in by the State. About $4.5 million of the total represented the first "in lieu of" tax payment from the Federal Government to Nevada, a payment for federally owned land in the State. This payment was distributed to the 17 Nevada counties that have tax-free, federally owned land. The monies were divided in proportion to the amount of Federal land in each county. Another $2.9 million of the total Federal revenues received was the State's share of mineral bonuses, royalties, and rentals paid under Section 35 of the Mineral Leasing Act of 1920. The Net Proceeds of Mine Tax, based on the gross yield of a mine less specified allowable deductions, brought the State $1.8 million for the year. The balance of the total, about $452,000, was Nevada's share of the bonus bid payments for geothermal lease sales in the State.

Public hearings were held throughout the State by the Department of the Interior during the year on changes to the 1872 Mining Law and the Bureau of Land Management's proposed surface mining regulations.

Sixty-five separate areas totaling 2.1 million acres were included in the U.S. Forest Service Roadless Area Review and Evaluation program in the State. Nevada's roadless areas were identified after the Forest Service conducted workshops in the State to gather public comments.

The Bureau of Land Management conducted three geothermal lease sales in the State during 1977. The sales involved 48,363.31 acres of land in four areas designated as Known Geothermal Resource Areas. These sales earned the agency $451,984.

Representatives from the State's Tax Commission met with Nevada barite producers in June to discuss a special tax assessment to be levied on producers who fail to provide full information on costs and profits. After several more meetings, a policy was established to use $18 as a base price per ton, with increases or decreases to be regulated by changes in the wholesale price index for nonmetallic minerals at the end of every 6-month period.

The 1977 Nevada Legislature created an Oil, Gas and Mining Board to act as an advisory group to the State's Director of Natural Resources. The board's seven members were appointed by the Governor and include professionals in the mining industry and two members of the public. The legislature also created a 3-member Nevada Department of Energy and gave it the task of reducing the State's energy consumption by 6.7% by 1980. The new department is non-regulatory and serves mainly as an advisory group to the Nevada Public Service Commission.

About 8,000 mining claims were registered with the Bureau of Land Management during the year, as required by the Federal Land Policy and Management Act of 1976. These registered claims account for about 15% of the estimated 50,000 to 60,000 claims in the State.

Regulations governing the drilling of geothermal wells in Nevada were tentatively adopted in October by the state engineer. The regulations require State licensing of persons who drill exploratory holes. When drilling is completed, the regulations would require the wells to be sealed for safety purposes and to be free of contamination from any surface material.

The U.S. Bureau of Mines Reno (Nevada) Metallurgy Research Center entered into a cooperative cost-sharing agreement during the year with four major lead producers, St. Joe Minerals Corp., AMAX Inc., ASARCO Inc., and COMINCO Inc., to make a feasibility study on a process of ferric chloride leaching of galena concentrates and fused-salt electrolysis of lead chloride. The research center also continued work aimed at finding a better additive for agglomerating the finely-divided clayey material present in gold and silver ores. An additive is sought that would enhance the percolation flow rates of the cyanide leach solution. The use of portland cement instead of lime for agglomerating the slimes appears very promising.

The Bureau of Mines Boulder City (Nevada) Metallurgy Engineering Laboratory developed a process that uses sulfur as a partial replacement for the asphalt binder in asphaltic concrete paving materials. The process was demonstrated by the successful placement of a 2,100-foot strip of sulfur-asphalt pavement on U.S. Highway 93 near Boulder City. Test results to date show that the sulfur-asphalt pavement performed equally as well or better than conventional asphalt pavements. Another project the Boulder City laboratory worked on was the evaluation of various processes for the production of alumina from nonbauxite domestic resources. Studies were conducted on a miniplant scale of 20 to 40 pounds of alumina production per hour.

During the year, the Bureau of Mines awarded two contracts for research work to the University of Nevada System. One was a $25,165 contract granted to the Mackay School of Mines for research on the fundamentals of chromite flotation. The other was a $19,000 contract awarded to the Desert Research Institute Water Resources Center for work on the environmental monitoring of alumina miniplant effluents.

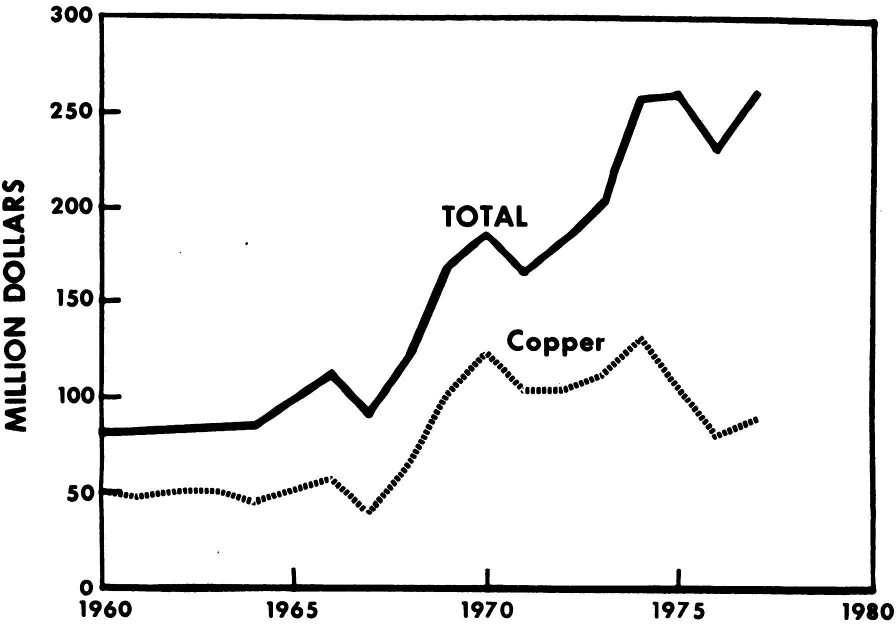

Figure 1.—Value of copper and total value of mineral production in Nevada.

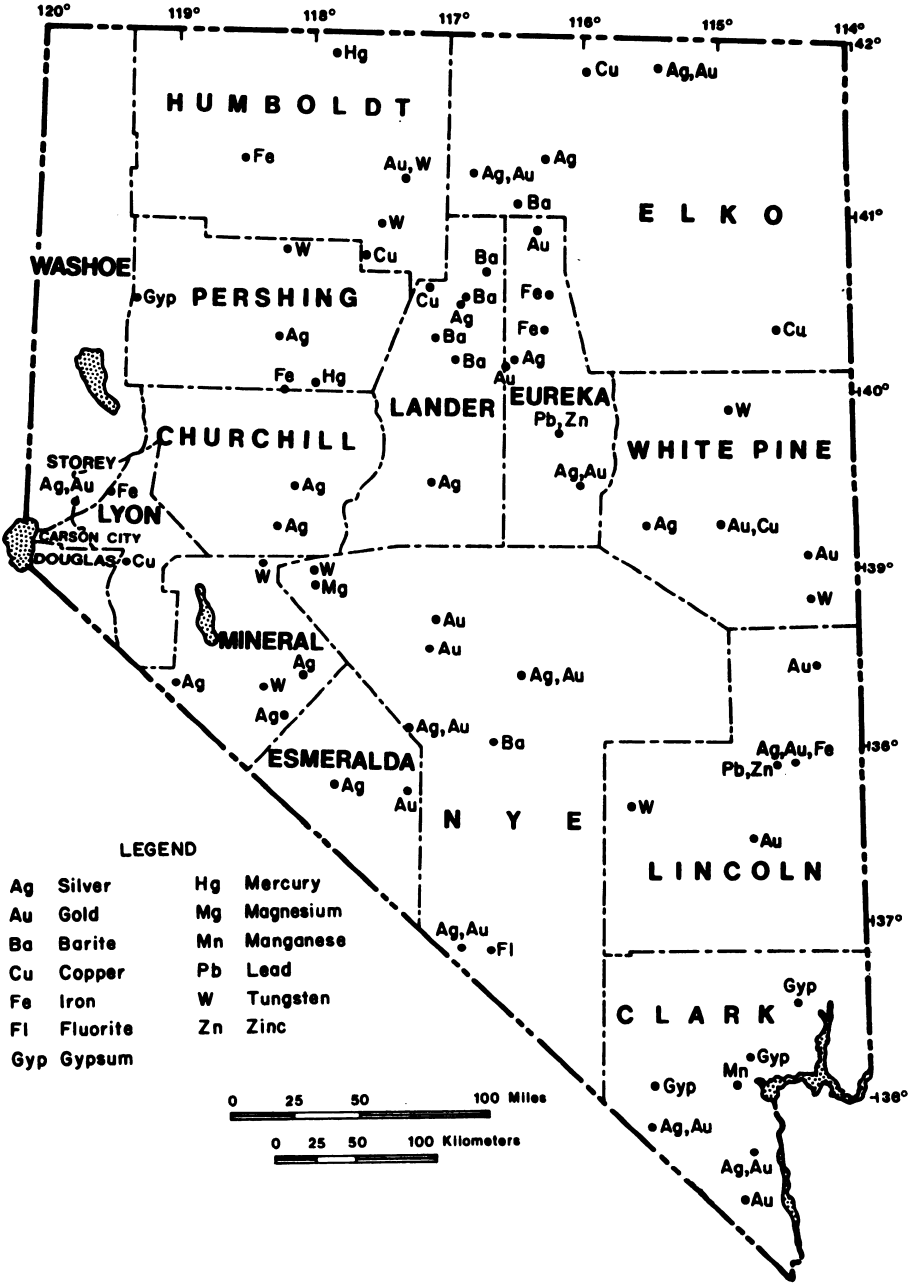

Figure 2.—Generalized map of selected mineral industries in Nevada.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—No activity was reported from any Nevada antimony mine in 1977.

Copper.—Cepper output increased 15% above that of 1976, making Nevada the Nation's fifth largest copper-producing State in 1977. Most of the output came from operations of The Anaconda Company in Lyon and Elko Counties, Kennecott Copper Corp. in White Pine County, Duval in Lander County, and Ranchers Exploration & Development Corp.'s Big Mike mine near Winnemucca.

Gold.—Nevada was the Nation's leading gold producer in 1977 with 29% of the total U.S. output. Gold output in the State increased 13% compared with that of 1976. Four lode gold mines, the Carlin Gold Mining Co., Smoky Valley Mining Co., Standard Slag Co. (the Atlanta mine), and the Idaho Mining Co., provided most of the total production. The remainder was produced as byproduct gold from copper ores. A total of 22 mines were involved in gold production. Placer gold recovery was insignificant by comparison, with only one property in Clark County yielding a few ounces.

Table 4.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing		Material sold or treated[1] (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1975, total	32	2	21,712,404	332,814	$53,746,132	1,608,735	$7,110,609
1976, total	40	1	13,752,995	287,962	36,087,398	783,892	3,409,934
1977:							
Clark	--	1	--	7	1,038	75	347
Elko	3	--	389,589	W	W	51,642	238,586
Eureka	3	--	847,044	189,003	28,031,035	9,227	42,629
Lincoln	3	--	237,538	W	W	192,387	888,828
Lyon	1	--	7,993,814	--	--	--	--
White Pine	2	--	4,676,039	10,977	1,627,999	64,405	297,551
Undistributed[2]	10	--	4,306,630	124,016	18,392,814	420,666	1,943,477
Total	22	1	18,450,654	324,003	48,052,886	738,402	3,411,418

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	81,210	$104,273,989	2,976	$1,279,856	5,496	$4,287,150	$170,697,736
1976, total	58,160	80,958,245	582	268,896	1,438	1,064,432	121,788,905
1977:							
Clark	--	--	--	--	--	--	1,385
Elko	3,458	4,620,525	7	4,604	1	481	10,195,644
Eureka	1	1,218	6	3,786	2	1,656	28,080,324
Lincoln	3	3,819	723	443,646	1,669	1,148,049	4,311,522
Lyon	27,488	36,724,230	--	--	--	--	36,724,230
White Pine	25,814	34,487,073	--	--	--	--	36,412,623
Undistributed[2]	10,297	13,756,437	7	4,063	--	--	26,938,163
Total	67,061	89,593,302	743	456,099	1,672	1,150,186	142,663,891

W Withheld to avoid disclosing company proprietary data; included in "Undistributed."

[1] Does not include gravel washed.

[2] Includes Churchill, Douglas, Lander, Nye, Pershing, and Storey Counties combined to avoid disclosing company proprietary data, and items indicated by symbol W.

Table 5.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated[2] (thousand short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold[3]	9	4,176	280,755	201,292	--	--	--
Silver[3]	4	22	7	3,073	--	8	1
Copper[3]	4	14,138	43,186	387,248	60,837	7	--
Lead, lead-zinc, zinc[4]	3	105	48	146,714	4	729	1,671
Total[5]	20	18,441	323,996	738,327	60,841	743	1,672
Other lode material:							
Copper precipitates	4	9	--	--	6,220	--	--
Total lode material[5]	22	18,451	323,996	738,327	67,061	743	1,672
Placer	1	--	7	75	--	--	--
Grand total	23	18,451	324,003	738,402	67,061	743	1,672

[1] Detail will not necessarily add to totals shown because some mines produce more than one class of material.
[2] Does not include gravel washed.
[3] Includes material that was leached.
[4] Combined to avoid disclosing company proprietary data.
[5] Data may not add to totals shown because of independent rounding.

Table 6.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Cyanidation	280,761	201,742	--	--	--
Smelting of concentrates	42,859	531,116	48,472	735	1,671
Leaching	(1)	(1)	12,105	--	--
Direct smelting of:					
Ore	376	5,469	264	7	1
Copper precipitates	--	--	6,220	--	--
Total lode material[2]	323,996	738,327	67,061	743	1,672
Placer	7	75	--	--	--
Grand total	324,003	738,402	67,061	743	1,672

[1] Included in cyanidation.
[2] Data may not add to totals shown because of independent rounding.

Iron.—Usable iron ore production was 2% higher in 1977 than in the previous year. The total output was direct-shipping-grade ores and was produced by Nevada Barth Corp. in Eureka County and Cooney Bros. in Pershing County.

Lead.—A total of four lode mines contributed to Nevada's lead output. Lead production was 28% more than in 1976. The Pan American lead-zinc mine in Lincoln County dominated the Nevada lead industry in 1976.

Mercury.—Production of mercury in 1977 increased moderately above that of 1976. Nevada continued to be the Nation's leading mercury-mining State, producing the bulk of mercury mined in the Nation during the year. The McDermitt mine, located in Humboldt County and operated as a joint venture between Mineral Exploration and Placer Amex, was the largest mercury-producing mine in the United States. The other mercury producer in Nevada was the Carlin Gold Mining Co., which continued to produce mercury as a byproduct from its gold mine in Eureka County.

Molybdenum.—Molybdenum was recovered by Kennecott as a co-product of copper ores treated at the McGill concentrator in White Pine County. Both production and shipments were substantially higher than in 1976.

Silver.—The production of silver decreased 6% from that of 1976. The number of lode silver mines decreased from 31 in 1976 to 16 in 1977. As in the previous year, the copper ores yielded most of the total lode silver with the remainder coming from silver, silver-gold, zinc, lead, and lead-zinc ores.

Tungsten.—The number of active tungsten properties in Nevada increased from 15 in 1976 to 28 in 1977. The production of tungsten concentrate increased 166% in 1977 compared with 1976 production. This increase can be attributed to the opening of new mines, the reactivation of old mines, and a return to full production at the Emerson mine.

Most of the concentrates output was shipped to Kennametal's tungsten carbide plant in Churchill County and to Union Carbide's Pine Creek ammonium paratungstate plant near Bishop, Calif.

Zinc.—Zinc output in 1977 was up 16% from that of 1976. Three lode mines accounted for the total zinc production. The Pan American lead-zinc mine in Lincoln County again dominated Nevada's zinc industry.

NONMETALS

Barite.—The quantity of primary barite sold or used by Nevada producers increased 29%, compared with the quantity sold or used in 1976, and the quantity of ground and crushed barite increased 74%. The value of primary ore was about the same as that of 1976, and ground, crushed ore value decreased 38%. The number of active mines decreased from 10 in 1976 to 8 in 1977. NL Industries, Inc., and Dresser Minerals ground barite in their respective plants at Dunphy in Eureka County and Battle Mountain in Lander County. Ground barite was also produced by Milchem, Inc., in its Bateman plant near Battle Mountain. Three new plants were dedicated in the vicinity of Battle Mountain by IMCO Services, Inc. Standard Slag shipped its crude ore from the Old Soldier mine to their plant near Fallon for further processing. Almost all the ground and crushed barite was sold for use in well drilling. FMC Corp. continued to ship crude ore from its Mountain Springs mine in Lander County to the company plant in Modesto, Calif., for use in manufacturing barite chemicals.

Cement.—Portland cement was produced by the Nevada Cement Co. in a dry-process plant at Fernley in Lyon County. Shipments decreased 1%, but value increased 9% compared with the 1976 data. Most of the cement was used by manufacturers of ready-mix concrete and concrete products, building materials dealers, and highway contractors.

Clays.—Clay sold or used increased 43% in quantity compared with the 1976 total. The clays were produced from mine operations in the following counties: one each in Clark, Esmeralda, Humboldt, Lincoln, Pershing and Washoe Counties, and three in Nye County. Common clay was mined by Nevada Cement at a deposit near Flanigan in Washoe County for use at the company's cement plant in Lyon County. Bentonite was mined by Western Talc Co. (R. T. Vanderbilt Company) from the Toddy pit in Clark County, the Blanco pit near Mina in Esmeralda County, and the New Discovery pit near Beatty in Nye County. The K. W. Snyder Co. mined bentonite at the Hi Hopes pit 15 miles west of Winnemucca in Humboldt County. Soil conditioner was produced by Good Earth Corp. near Panaca in Lincoln County. Industrial Mineral Ventures, Inc., mined bentonite in the Amargosa area 10 miles south of Lathrop Wells in Nye County.

Diatomite.—Sales of prepared diatomite increased 4% in quantity and 17% in value compared with sales for 1976. As in 1976, five deposits were mined, one each in Churchill, Esmeralda, Lyon, Pershing, and Storey Counties. No sales of crude materials were reported. Eagle-Picher Industries, Inc., continued to be the largest Nevada diatomite producer. Eagle-Picher produced diatomite from its Celaton mine in Pershing County and the Tunnel Hill mine in Storey County. Cyprus Industrial Minerals Co., the second largest producer, supplied diatomite from its mine in Churchill County to its plant at Fernley in Lyon County. Product sales were mainly for filtration, filler, lightweight aggregate, and insulation. The third producer in Nevada was GREFCO, Inc., that operated a mine at Basalt and a plant near Mina, both in Esmeralda County.

Fluorspar.—Both production and shipments of fluorspar declined from 1976 levels. Ceramic- and metallurgical-grade fluorspar were produced and shipped from the J. Irving Crowell, Jr., Daisy mine in Nye County.

Gem Stones.—In 1977, the collecting of precious or semiprecious gem stones was of interest to a selected group of individuals, both as hobbyists and as small commercial dealers. Accurate data on output are not available. During the year, turquoise production came from six mines, one of them being a copper mine. Most turquoise production, in terms of value, came from sources in

Churchill, Esmeralda, Lander, Mineral, and Nye Counties.

Gypsum.—Crude gypsum production increased 57% in quantity from that of 1976. The output was used in Nevada and California plants for making plaster and board products and as a retarder in portland cement.

Gypsum was mined by The Flintkote Co.; Pacific Coast Building Product, Inc.; Art Wilson; and United States Gypsum Co. in Clark, Lincoln, Lyon, and Pershing Counties, respectively. U.S. Gypsum, Flintkote, and Pacific Coast calcined gypsum in Pershing and Clark Counties. Calcined gypsum increased 20% over the total produced in 1976.

Lime.—Lime production was 5% less than it was in 1976. Most lime shipments were made to the steel, paper, glass, and chemical industries. Shipments were made throughout the western States, with California consumers taking most of the production.

U.S. Lime, a division of The Flintkote Co. operated three plants in Clark County, producing quicklime at Apex, hydrated lime at Sloan, and both quicklime and hydrated lime at Henderson. Morrison and Weatherly Chemical Products produced lime at McGill in White Pine County, primarily for use by Kennecott.

Lithium Compounds.—The output of lithium carbonate from the Silverpeak facility of Foote Mineral Co. in Esmeralda County increased 13% compared with that of 1976. The major use of lithium carbonate continued to be as a cell additive in aluminum potlines.

Magnesite and Brucite.—Basic, Inc., near Gabbs, in Nye County was the sole producer of magnesite. Production was slightly more than in 1976. A high percentage of the crude magnesite output was consumed by the company in making caustic calcined and refractory products. The major consuming industries of caustic calcined magnesias were those making oxychloride and oxysulfate cements, chemicals, synthetic rubber, rayon, and fertilizer.

No brucite was mined.

Perlite.—Crude perlite sales levels in 1977 were about the same as in 1976. All of Nevada's crude perlite was produced by two companies. U.S. Gypsum operated the Pearl Hill quarry in Pershing County where crude perlite ore was expanded and used in the company's wallboard plant in Washoe County. The Delamore Perlite Co. worked the Mackie claims in Lincoln County and shipped the crude material to out-of-State customers.

Pumice (Volcanic Cinder).—Output of pumice, pumicite, and volcanic cinder was up 69% from the 1976 level. The large increase was primarily due to the building boom and consequent increased demand for concrete aggregate. The material also was used in concrete admixture, landscaping, and roofing. Volcanic cinder from Savage Construction Co., Inc.'s Cinderlite Aggregates property in Carson City was prepared for use in concrete aggregates, road construction, landscaping, and roofing. Pumice was mined by Construction Aggregate Co. in Churchill County, and Cind-R-Lite Block Co. in Nye County mined volcanic cinder from the Cinder Cone deposit southeast of Beatty for concrete aggregate and landscaping. Pumicite was mined from the Naturalite group of claims in Storey County. Pumice from the Rilite Aggregate Co. property in Washoe County was prepared for use in concrete aggregate.

Salt.—The sole producer of salt in the State was Huck Salt Co., which leased and operated the Leslie Salt Co.'s solar evaporation plant in Churchill County. Salt produced by solar evaporation was harvested from a dry lakebed near Sand Springs in Churchill County. Most of the output was sold for ice control on Nevada's State, County, and local roads. Lesser quantities were used by meat packers, tanners, dairy industries, water conditioning service companies, metal processors, and in mixes.

Sand and Gravel.—Output of sand and gravel increased 5% over the 1976 output. There were 88 active operations during the year, or 7 less than in 1976. Of these, 5% were classified for industrial use, and 95% were classified for government and contractor construction use.

Stone.—Eleven companies crushed stone at 163 quarries for lime, cement, roadbase aggregate, and other uses. Output declined 12% from 1976 to 1977, to 1.67 million tons valued at $5.5 million. Leading producers were Flintkote, Centex Corp., and the Clark County Highway Department. The unit value of material produced this year increased 16% over the unit value of last year's stone, even though production was down.

Most of the limestone was converted to lime or used as a metallurgical flux, primarily in the smelting of copper. Most of the dolomite was used in lime manufacturing, and most of the granite and quartzite was used in road construction. Marble was quarried in Mineral County for terrazzo.

Public works crews and contractors produced limestone, granite, and quartzite in several counties for use as riprap, roadbase, and concrete aggregate.

Talc.—Nevada's talc output came from the Oasis mine in Esmeralda County and increased 67% compared with talc produced in 1976. All shipments went to out-of-State grinding mills.

Table 7.—Nevada: Construction and industrial sand and gravel sold or used

(Thousand short tons and thousand dollars)

	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	2,667	4,295	2,992	6,436
Gravel	6,449	12,225	6,912	13,105
Total[1]	9,116	16,519	9,904	19,542
Industrial sand	555	3,587	281	1,630
Grand total	9,671	20,106	10,185	21,172

[1]Data may not add to totals shown because of independent rounding.

Table 8.—Nevada: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	2,687	5,538	3,543	8,451
Concrete products (cement blocks, bricks, pipe, etc.)	627	1,031	271	648
Asphaltic concrete aggregates and other bituminous mixtures	1,937	4,308	1,345	2,738
Roadbase and coverings	2,960	4,354	3,243	5,433
Fill	782	867	1,454	2,094
Railroad ballast	--	--	--	--
Other uses	122	422	47	178
Total[1]	9,116	16,519	9,904	19,542

[1]Data may not add to totals shown because of independent rounding.

MINERAL FUELS

Petroleum.—The Department of Conservation and Natural Resources, Division of Mineral Resources, issued 36 oil drilling permits in the State during the year, with the majority being for the new Trap Springs field. Of this number, 26 wells were started and completed. Eighteen of the 26 wells were abandoned as dry holes, and 8 wells were completed for production. The Eagle Springs oil field continued to be an active oil-producing field during the year. An average of 15 wells produced oil from these two fields.

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[1] State Liaison Officer.

[2] Liaison program assistant. Both authors are with the State Liaison Office, Bureau of Mines, Carson City, Nev.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
All Minerals, Inc	Box 63 Round Mountain, NV 89045	Surface mine	Nye.
Dresser Minerals	Box 375 Battle Mountain, NV 89820	do	Lander.
FMC Corp	Box 531 Battle Mountain, NV 89820	do	Do.
IMCO Services, Inc	Box 448 Battle Mountain, NV 89820	Plant	Do.
Milchem, Inc	Box 272 Battle Mountain, NV 89820	Surface mine	Do.
The Milwhite Co., Inc	Box 1909 Elko, NV 89801	do	Do.
NL Industries, Inc	Box 1675 Houston, TX 77001	do	Elko.
Standard Slag Co	Box 10477 Reno, NV 89510	do	Nye.
Tom Norris Mining Co	Box 231 Battle Mountain, NV 89820	do	Lander.
Cement: Nevada Cement Co.[1]	Fernley, NV 89408	Plant	Lyon.
Clays:			
Centex Corp	Fernley, NV 89048	Pit	Pershing.
Good Earth Corp	726 E. Sahara Ave. Las Vegas, NV 89104	Pit	Lincoln.
Industrial Minerals Ventures	Box 237 Lathrop Wells, NV 89020	Surface mine	Nye.
Kelly-Moore Paint Co	1015 Commercial St. San Carlos, CA 94070	Pit	Pershing.
Viking Minerals, Inc	Box 546 Oakdale, CA 95361	Surface mine	Nye.
Western Talc Co	Box 398 Beatty, NV 89003	Underground mine.	Do.
Copper:			
The Anaconda Company[2]	Box 1000 Weed Heights, NV 89443	Surface mine	Lyon.
	Box 65 Wendover, UT 84083	Open pit	Elko.
Duval Corp.[3]	Box 451 Battle Mountain, NV 89820	Surface mine	Lander.
Kennecott Copper Corp.[4]	McGill, NV 89318	do	White Pine.
Diatomite:			
Cyprus Industrial Minerals Co	Box 455 Fernley, NV 89408	do	Churchill.
Eagle-Picher Industries, Inc	Box 1869 Reno, NV 89505	do	Pershing and Storey.
Fluorspar: J. Irving Crowell, Jr	Box 96 Beatty, NV 89003	Underground mine.	Nye.
Gold:			
Carlin Gold Mining Co.[5]	Box 979 Carlin, NV 89822	Surface mine	Elko and Eureka.
Cortez Gold Mines	Cortez, NV 89821	do	Lander.
Idaho Mining Co	Box 328 Eureka, NV 89316	do	Eureka.
Smoky Valley Mining Co	Box 480 Round Mountain, NV 89045	do	Nye.
Standard Slag Co	Box 97 Pioche, NV 89043	do	Lincoln.
Gypsum:			
The Flintkote Co.[6]	Box 127 Henderson, NV 89015	do	Clark.
Pabco	Box 14186 Las Vegas, NV 89114	do	Do.
United States Gypsum Co.[7]	Empire, NV 89045	do	Pershing.
Iron ore:			
Cooney Bros	Box 568 Lovelock, NV 89419	Surface mine	Pershing.
Nevada Barth Corp	Box 425 Carlin, NV 89822	do	Eureka.
Lead:			
Mt. Hope Mines, Inc	Box 218 Eureka, NV 89316	Underground mine.	Eureka.
Pan American Mine,[8] Bunker Hill Co	Box 276 Pioche, NV 89043	Surface mine	Lincoln.
Lime: Morrison and Weatherly Chemical Products.[9]	East Ely, NV 89315	Rotary kilns	White Pine.
Lithium: Foote Mineral Co	Silverpeak, NV 89047	Dry lake brines.	Esmeralda.
Magnesite: Basic, Inc.[10]	Box 4 Gabbs, NV 89409	Surface mine	Nye.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Mercury: McDermitt Mine	Box 101 McDermitt, NV 89421	Open pit	Humboldt.
Perlite: Mackie Perlite Mine	Box 217 Pioche, NV 89043	Underground mine.	Lincoln.
Petroleum:			
Ely Crude Oil	Via Tonopah Stage Ely, NV 89301	Wells	Nye.
Northwest Exploration Co	Box 90 Farmington, NM 87401	do	Do.
Toiyabe Oil, Inc	Box 549 Tonopah, NV 89049	do	Do.
Western Oil Lands, Inc	380 Linden Street Reno, NV 89502	do	Do.
Pumice:			
Cind-R-Lite Block Co	3333 Cinder Lane Las Vegas, NV 89103	Open pit	Nye.
Rilite Aggregate Co	Box 5665 Reno, NV 89503	Surface mine	Washoe.
Savage Construction Co	Box 970 Carson City, NV 89701	Open pit	Carson City.
Salt: Huck Salt Co	Rt. 2, Box 33 Fallon, NV 89406	Solar evaporation plant.	Churchill.
Sand and gravel:			
Diamond Construction Co	4020 E. Cheyenne Ave. Las Vegas, NV 89030	Pit	Clark.
Hess Rock Products Co	Route 1 McCarran Ranch Sparks, NV 89431	Pit	Washoe.
Nevada Aggregates and Asphalt	Box 7424 Reno, NV 89502	Pit	Do.
Nevada Rock & Sand Co	Box 2775 Huntridge Station Las Vegas, NV 89101	Pit	Clark.
Robert L. Helms Construction & Development	Drawer 608 Sparks, NV 89431	Pit	Washoe.
Southern Nevada Paving, Inc	3555 Polaris Las Vegas, NV 89101	Pit	Clark.
Stewart Bros. Co	Box 2775 Huntdridge Station Las Vegas, NV 89101	Pit	Nye.
W.M.C. Engineering	Box 1301 Elko, NV 89801	Pit	Elko.
W.M.K. Transit Mix, Inc	1606 Industrial Rd. Las Vegas, NV 89102	Pit	Clark.
Wells-Cargo, Inc.[10]	Box 14037 Las Vegas, NV 89114	Pit	Nye.
Tungsten:			
Boundy Mining, Inc	Box 173 Ely, NV 89301	Surface mine	White Pine.
Oxbow Tungsten Mine, Inc	Box 175 Mountain City, NV 89831	Surface mine	Elko.
Tungsten Properties Limited	Box A Imlay, NV 89418	Tailings and underground mine.	Pershing.
Union Carbide Corp	Box 307 Alamo, NV 89001	Underground mine.	Lincoln.

[1] Also clays and stone.
[2] Also gold and silver.
[3] Also gold, silver and lead.
[4] Also gold, silver and molybdenum.
[5] Also mercury.
[6] Also lime and stone.
[7] Also perlite.
[8] Also silver and zinc.
[9] Also crude petroleum.
[10] Also stone.

The Mineral Industry of New Hampshire

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New Hampshire Department of Resources and Economic Development for collecting information on all minerals except fuels.

By William R. Barton[1] and Glenn W. Stewart[2]

The value of minerals produced in New Hampshire in 1977 was $20.7 million compared with $17.6 million in 1976, according to the Federal Bureau of Mines. The increase of 18% in value was due to general inflationary pressures in the economy as well as increased production of sand and gravel. Sand and gravel and stone represented more than 99% of the mineral wealth produced by New Hampshire miners. No metallic minerals or mineral fuels were produced.

A measure of the significance of minerals and mineral products to the New Hampshire economy may be gained from an analysis of the gross State product (GSP) figures issued annually by the Federal Reserve Bank of Boston. While mining represents only 0.3% of the GSP, construction is 5%, and manufacturing is an additional 29%. The manufacturing sector of the economy includes within its own total: 13% stone, clay, glass, and primary and fabricated metal manufacture; 34% machinery, electrical and electronic items, ordnance, and transport equipment; and 9% chemicals, rubber, and plastics. All of these categories are dependent upon mineral-derived products either entirely or in part. Even plastic, rubber, or organic chemical products may be more than 50% by weight mineral filler or extender in some cases.

About 600 of New Hampshire's 250,000 industrial workers are engaged in mining. However, 11,000 other persons work in mineral-dependent construction; and of the more than 90,000 in manufacturing; stone, clay, glass, and primary and fabricated metal products employ 9,000. An additional 32,000 persons are employed by other manufacturing which relies heavily on mineral-derived materials.

Minerals, and mineral products, are also important to the rail and truck transport industry of New Hampshire. Sand and gravel unittrain shipments from Ossipee Aggregates, Inc., to Boston, Mass., markets are the sustaining freight cargo for the line from Ossipee to Rochester. Dimension and crushed stone and sand and gravel are important cargo for truckers. National Gypsum Co. trucks are a familiar sight on New England highways transporting gypsum products from the Portsmouth plant to construction sites and materials dealers throughout the region.

Minerals and related products are almost the entire cargo list for the Port of Portsmouth. Petroleum products and liquefied natural gas are the principle items of commerce, followed by imports of salt by Granite State Minerals, Inc.; gypsum ore by National Gypsum Co.; and exports of scrap metal from the New Hampshire State Terminal pier. Such items constituted 99% of total cargo handled in 1977.

Compared with the national per capita average of 40,000 pounds of new mineral materials required annually, New Hampshire has indigenous production of approximately 18,000 pounds per capita. The State presently is fully self-sufficient only in sand and gravel and most stone varieties but must import most nonmetallic minerals and all required metals and mineral fuels from other States and foreign countries. While ranking 48th in value of mineral products, New Hampshire is 5th in value of dimension granite.

Two pieces of legislation that affected mining were New Hampshire House Bill 1117 to regulate sand and gravel mining and House Bill 543 to regulate all mining. Both bills were passed by the legislature and then vetoed by Governor Meldrim Thomson, Jr. Both vetoes were sustained.

Table 1.—Mineral production in New Hampshire[1]

Minerals	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel thousand short tons	[2]6,180	[2]$10,409	6,835	$13,888
Stone do	743	7,032	792	6,686
Combined value of other nonmetals	XX	138	XX	127
Total	XX	17,579	XX	20,701
Total 1967 constant dollars	XX	9,023	XX	[p]10,218

[p] Preliminary. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes industrial sand and gravel; included with "Combined value."

Table 2.—Value of mineral production in New Hampshire, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Belknap	W	$1,131	Sand and gravel.
Carroll	$1,494	1,896	Do.
Cheshire	979	1,057	Do.
Coos	447	703	Do.
Grafton	W	W	Sand and gravel, stone.
Hillsborough	6,683	W	Stone, sand and gravel.
Merrimack	3,678	W	Sand and gravel, stone.
Rockingham	W	W	Do.
Strafford	W	W	Sand and gravel, clays.
Sullivan	168	528	Sand and gravel.
Undistributed[1]	4,132	15,386	
Total[2]	17,579	20,701	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes gem stones and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of New Hampshire business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force — thousands	389.0	409.0	+5.1
Unemployment — do.	25.0	24.0	-4.0
Employment (nonagricultural):			
Mining — do.	.4	.4	--
Manufacturing — do.	94.5	101.1	+7.0
Contract construction — do.	14.3	17.9	+25.2
Transportation and public utilities — do.	12.1	12.3	+1.7
Wholesale and retail trade — do.	68.1	73.7	+8.2
Finance, insurance, real estate — do.	15.0	16.2	+8.0
Services — do.	59.0	63.0	+6.8
Government — do.	49.9	51.8	+3.8
Total nonagricultural employment — do.	313.3	336.4	+7.4
Personal income:			
Total — millions	$4,940	$5,547	+12.3
Per capita	$5,974	$6,536	+9.4
Construction activity:			
Number of private and public residential units authorized	5,995	6,702	+11.8
Value of nonresidential construction — millions	$60.9	$67.9	+11.5
Value of State road contract awards — do.	$45.0	$60.0	+33.3
Shipments of portland and masonry cement to and within the State — thousand short tons	249	276	+10.8
Mineral production value:			
Total crude mineral value — millions	$17.6	$20.7	+17.8
Value per capita, resident population	$21	$24	+14.3
Value per square mile	$1,889	$2,225	+17.8

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the New Hampshire mineral industry in 1977[1]

	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate	Nondisabling injuries	Nondisabling injury frequency rate
Sand and gravel:								
Surface	263	501,885	--	--	5	9.96	5	9.96
Office	46	71,263	--	--	--	--	--	--
Total	309	573,148	--	--	5	8.72	5	8.72
Stone:								
Surface	72	169,711	--	--	12	70.71	1	5.89
Mills	109	223,078	--	--	7	31.38	2	8.97
Office	34	65,286	--	--	--	--	--	--
Total	215	458,075	--	--	19	41.48	3	6.55
Clays:								
Surface	10	26,616	--	--	--	--	--	--
Mills	7	7,663	--	--	--	--	--	--
Office	2	3,440	--	--	--	--	--	--
Total	19	37,719	--	--	--	--	--	--
Gypsum:								
Mills	10	28,131	--	--	--	--	--	--
Office	1	312	--	--	--	--	--	--
Total	11	28,443	--	--	--	--	--	--
State total:								
Surface	345	698,212	--	--	17	24.35	6	8.59
Mills	126	258,872	--	--	7	27.04	2	7.73
Office	83	140,301	--	--	--	--	--	--
Grand total	554	1,097,385	--	--	24	21.87	8	7.29

[1] Data supplied by Mine Safety and Health Administration, U.S. Department of Labor.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—There are no cement plants in New Hampshire. In 1977, domestic producers reported they shipped 264,000 tons of finished portland cement and 12,000 tons of prepared masonry cement into the State. Respective figures in 1976 were 236,000 tons and 13,000 tons.

Clays.—Kane-Gonic Brick Corp. mined common clay to manufacture common brick. Output decreased compared with that of 1976 due to cessation of production by W. S. Goodrich, Inc. The clay was mined and manufactured into brick in Strafford County.

Diatomaceous Earth.—An application to test mine diatomaceous earth for 2 days from Lake Umbagog was denied by the State. The 2-day test was designed by applicants Franklin Yoffe and Peter Fuller to demonstrate that there would be no measurable adverse environmental effects from their proposed operation. Their proposal for a 2-day test mine followed several years of rejection of Mr. Yoffe's efforts to obtain a long-term mining permit.

Gem Stones.—The value of gem stones and mineral specimens collected was substantial in 1977. The old Ruggles mine, in a pegmatite near Grafton, was operated as a commercial tourist attraction. It was a center for mineral collectors as well as for those just wishing to tour the mine. Collecting bright green fluorite at the old Will Wise mine in Westmoreland was also popular, along with searching for amazonite, topaz, and smoky quartz in Conway granite areas. Some old mines in the Amonoosuc goldfields are also open to collectors and tourists.

Gypsum.—National Gypsum Co. calcined gypsum from Canada at its Portsmouth plant in Rockingham County. Output increased substantially. The plant was one of the only two gypsum plants active in New England. (The other was U.S. Gypsum Co. at Charlestown, Mass.)

Lime.—There are no lime plants in New Hampshire. Lime and ground limestone for use in the State are imported from elsewhere, mostly adjacent New England States.

Mica.—Mica was not produced in New Hampshire in 1977, and none of the mica mines in the State have been active for many years. Two firms, the Macallen Co., Inc. (division of Essex International, Inc.) at Newmarket and Concord Mica Corp., Penacook, fabricated mica purchased elsewhere.

Perlite.—National Gypsum Co. expanded perlite for plaster aggregate at Portsmouth, Rockingham County. The crude perlite was shipped into New Hampshire from Western States.

Salt.—The New Hampshire Highway Department used 140,308 tons of highway salt during 1976-77 compared with 146,137 tons in 1975-76. The slight drop in use was attributed to less freezing rain than had plagued highway cleaners the previous winter.

Sand and Gravel.—Production of sand and gravel increased 11% in tonnage and increased 33% in value compared with 1976. A total of 52 pits were operated in 10 counties by 39 operators or operating subsidiaries. The counties recording the highest production in 1977 were: Hillsborough and Merrimack, accounting for 40% of the total sand and gravel output. The leading commercial producers were Manchester Sand and Gravel & Cement Co.; Tilton Sand & Gravel, Inc.; Ossipee Aggregates Corp.; Hudson Sand and Gravel, Inc.; and J. J. Cronin Co. The New Hampshire Department of Public Works and Highways was another important producer, operating 10 pits.

In parts of New Hampshire, high-quality gravel deposits were being depleted very rapidly, preempted for other land use, or being placed under environmental restrictions that forbid mining or make it impractical. Increasingly, requests for permits to mine sand and gravel were being rejected by local zoning or planning boards, or were being subjected to long and costly court adjudication and hearings. The resultant pressure on construction mineral excavators has contributed to upward trends in prices for construction minerals.

Table 5.—New Hampshire: Construction sand and gravel sold or used by producers, by use

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	3,336	$3,643	$1.09	2,397	$4,445	$1.85
Gravel	2,845	6,661	2.34	4,438	9,443	2.13
Total or average[1]	6,180	10,409	1.68	6,835	13,888	2.03

[1] Data may not add to totals shown because of independent rounding.

Table 6.—New Hampshire: Sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	1,613	$3,734	$2.31	2,436	$5,540	$2.27
Concrete products (cement blocks, bricks, pipe, etc.)	353	713	2.02	283	714	2.53
Asphaltic concrete aggregates and other bituminous mixtures	1,227	2,425	1.98	1,450	3,053	2.11
Roadbase and coverings	1,359	1,515	1.11	1,503	2,877	1.91
Fill	1,397	1,681	1.20	816	1,080	1.32
Railroad ballast[1]	--	--	--	W	W	1.50
Other uses	232	340	1.47	331	600	1.81
Total or average[2]	6,180	10,409	1.68	6,835	13,888	2.03

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Railroad ballast included in "Total."

[2] Data may not add to totals shown because of independent rounding.

Stone.—Stone production increased 7% in tonnage and decreased 5% in value in 1977. Dimension granite was quarried in Hillsborough and Merrimack Counties for curbing (54%), dressed architectural, construction, and monumental stone. Fabrication plants were also operated in both counties. Among the States, New Hampshire ranked third in output of dimension granite. At yearend, Swenson Building Granite Corp. (not John Swenson Granite Co., Inc.) was for sale.

Crushed traprock was produced by Lebanon Crushed Stone, Inc., in Grafton County and by Iafolla Industries, Inc., in Rockingham County. The New Hampshire Department of Public Works and Highways crushed granite in Hillsborough and Merrimack Counties for road aggregate.

Total stone production was 792,000 tons valued at $6.7 million in 1977, compared with production of 743,000 tons valued at $7.0 million in 1976. Output of dimension stone was 73,000 tons valued at $4.65 million. Crushed stone production was approximately 719,000 tons valued at $2.04 million.

Because of increased restrictions upon gravel mining and depletion of high-quality and available gravel resources, crushed stone quarries were increasingly turned to as the only feasible alternative for needed construction aggregate supplies.

Table 7.—New Hampshire: Crushed stone, sold or used by producers[1] by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	W	W	261	888
Bituminous aggregate	W	W	185	512
Concrete aggregate	W	W	140	390
Dense-graded roadbase stone	417	939	W	W
Riprap and jetty stone	W	W	56	159
Other uses[2]	261	820	77	88
Total	678	1,759	719	[3]2,036

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Includes granite and traprock.

[2] Includes stone used in surface treatment aggregate and filter stone (1976) and uses indicated by symbol W.

[3] Data do not add to total shown because of independent rounding.

METALS

Base Metals.—Considerable prospecting occurred in old copper and zinc mining districts of New Hampshire. Standard Metals Corp. continued to hold the Higgins property near West Milan but had no immediate plans for it.

Gold.—Small amounts of gold were panned from the old Amonoosuc mining district by prospectors and mineral collectors. The Wild Amonoosuc River near Swiftwater and Benton was particularly productive.

Uranium and Thorium.—Interest in the uranium and thorium potential of New Hampshire granites was stimulated by an application for a prospecting permit on 41,000 acres of White Mountain National Forest. Applicants Robert Economou and Frederick Young proposed radiometric prospecting followed by diamond core drilling of most favorable zones. Much of the acreage for which they sought prospecting permits was subject to restrictive management policies under the White Mountain Forest plans of the U.S. Forest Service.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Kane-Gonic Brick Corp	Gonic, NH 03867	Pit	Strafford.
Gypsum (calcined):			
National Gypsum Co.[1]	325 Delaware Ave. Buffalo, NY 14202	Plant	Rockingham.
Sand and gravel:			
Ralph L. Bezzell, Inc	66 School St. Merrimack, MA 01860	Pit	Do.
Alvin J. Coleman & Son, Inc	Route 16 Conway, NH 03818	Pit	Carroll.
J. J. Cronin Co	Box 176 North Reading, MA 01864	Pit	Rockingham.
Hudson Sand and Gravel	85 Greeley St. Hudson, NH 03051	Pit	Hillsborough.
Iafolla Industries Inc.[2]	Peverly Hill Rd. Portsmouth, NH 03801	Pit	Rockingham and Strafford.
Keene Sand & Gravel	725 Main St. Keene, NH 03431	Pit	Cheshire.
Manchester Sand, Gravel & Cement Co.[3]	Box 415 Hookset, NH 03106	Pit	Merrimack.
New Hampshire State Public Works and Highway Department.	85 Loudon Rd. Concord, NH 03301	Pits	Statewide.
Ossipee Aggregates Corp	Ossipee, NH 03864	Pit	Carroll.
Plourde Sand & Gravel Co	Suncook, NH 03275	Pit	Merrimack.
Ryder Concrete Inc	Milford, NH 03055	Pit	Hillsborough.
Tilton Sand & Gravel, Inc	Tilton, NH 03276	Pit	Belknap.
F. W. Whitcomb Construction Corp.	Box 429 Bellows Falls, VT 05101	Pit	Cheshire.

See footnotes at end of table.

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[1] State Liaison Officer, Bureau of Mines, Newmarket, N.H.

[2] State Geologist, Department of Resources and Economic Development, Durham, N.H.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Granite, dimension:			
Kitledge Granite Corp	Armory Rd. Milford, NH 03055	Quarry	Hillsborough.
John Swenson Granite Co., Inc	Box 1122 Lowell, MA 01852	do	Do.
Maine-New Hampshire Granite Co	North State St. Concord, NH 03301	do	Merrimack.
Traprock:			
Lebanon Crushed Stone, Inc	Plainfield Rd. West Lebanon, NH 03784	do	Grafton.

[1] Also expanded perlite.

[2] Also traprock.

[3] Also crushed granite.

The Mineral Industry of New Jersey

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of Interior, and the New Jersey Division of Natural Resources, Bureau of Geology and Topography, for collecting information on all minerals except fuels.

By William Kebblish[1]

The value of New Jersey's mineral production totaled $117 million or 2% less than that of 1976. Sand and gravel, one of the State's two major mineral products, decreased 22% in quantity and 26% in value. Stone, the other leading commodity, increased 16% in quantity and 19% in value. Zinc, which ranks third, decreased slightly both in quantity and value. Sussex was the leading mineral-producing county and was followed in descending order of value by Somerset, Cumberland, Passaic, Morris, and Ocean. Mineral production was reported for all counties except Salem.

Table 1.—Mineral production in New Jersey[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ____ thousand short tons__	61	$331	68	$374
Gem stones ____	NA	17	NA	17
Peat ____ thousand short tons__	22	568	30	769
Sand and gravel ____ do____	12,420	39,439	9,697	29,327
Stone, crushed[2] ____ do____	11,234	39,012	12,993	46,621
Zinc (recoverable content of ores, etc.) ____ short tons__	33,767	24,987	33,464	23,024
Combined value of iron ore (1977), lime, magnesium compounds, manganiferous residuum (1976), marl (greensand), stone (dimension), and titanium concentrate (ilmenite) ____	XX	15,532	XX	16,928
Total ____	XX	119,886	XX	117,060
Total 1967 constant dollars ____	XX	61,537	XX	[P]57,801

[P]Preliminary. NA Not available. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes dimension stone; value included in "Combined value" figures.

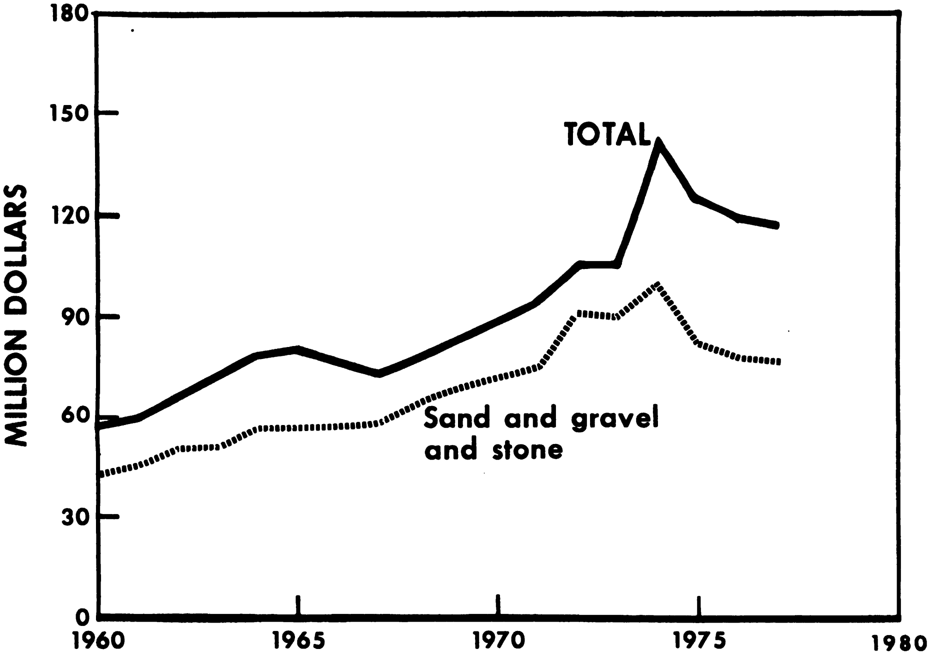

Figure 1.—Value of sand and gravel and stone, and total value of mineral production in New Jersey.

Table 2.—Value of mineral production in New Jersey, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Atlantic	W	W	Sand and gravel.
Bergen	W	W	Do.
Burlington	$4,593	W	Do.
Camden	1,546	$1,983	Do.
Cape May	W	W	Magnesium compounds, sand and gravel.
Cumberland	W	W	Sand and gravel, clays.
Essex	W	W	Stone.
Gloucester	W	W	Greensand marl, sand and gravel.
Hudson	W	W	Stone.
Hunterdon	W	W	Do.
Mercer	W	W	Do.
Middlesex	W	W	Sand and gravel, clays.
Monmouth	574	464	Sand and gravel.
Morris	W	W	Sand and gravel, stone.
Ocean	W	W	Ilmenite, sand and gravel.
Passaic	6,972	6,530	Stone, sand and gravel.
Somerset	W	19,096	Stone, clays.
Sussex	W	W	Zinc, stone, lime, peat, sand and gravel.
Union	W	W	Stone.
Warren	W	W	Sand and gravel, peat, stone.
Undistributed[2]	106,198	88,987	
Total	[3]119,886	117,060	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1] Salem County is not listed because no production was reported.
[2] Includes gem stones, iron ore, and values indicated by symbol W.
[3] Data do not add to total shown because of independent rounding.

Table 3.—Indicators of New Jersey business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	3,305.0	3,367.0	+1.9
Unemployment	do	345.0	316.0	-8.4
Employment (nonagricultural):				
Mining	do	2.7	NA	--
Manufacturing	do	747.4	753.3	+.8
Contract construction	do	94.6	NA	--
Transportation and public utilities	do	175.9	NA	--
Wholesale and retail trade	do	618.3	NA	--
Finance, insurance, real estate	do	138.2	NA	--
Services	do	490.1	NA	--
Government	do	470.4	NA	--
Total nonagricultural employment	do	2,737.6	NA	--
Personal income:				
Total	millions	$53,673	$58,589	+9.2
Per capita		$7,314	$7,994	+9.3
Construction activity:				
Number of private and public residential units authorized		30,750	34,665	+12.7
Value of nonresidential construction	millions	$467.5	$476.1	+1.8
Value of State road contract awards	do	$69.6	$250.0	+259.2
Shipments of portland and masonry cement to and within the State	thousand short tons	1,420	1,391	-2.0
Mineral production value:				
Total crude mineral value	millions	$119.9	$117.1	-2.3
Value per capita, resident population		$16	$16	--
Value per square mile		$15,299	$14,939	-2.4

[p] Preliminary. NA Not available.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and Federal Bureau of Mines.

Legislation and Government Programs.—Governor Byrne signed into law a bill creating the new State Department of Energy. The new department would have broad powers to plan for fuel shortages and to impose fuel conservation measures. Also signed into law was an energy conservation plan requiring homeowners to meet insulation standards, replace gas furnace pilot lights, and adopt other energy-saving practices. Utilities supported the conservation measures and suggested all new homes have 6 inches of attic insulation and 3-1/2 inches of wall insulation. To assist the public in financing, the utilities provided a 3-month interest-free loan to consumers installing additional insulation in their homes. In Trenton, officials received Federal funds to conduct feasibility analysis and design of an Integrated Community Energy System (ICES) that uses waste heat from electric generation to heat and cool nearby buildings.

The Department of Environmental Protection (DEP) issued variances to glass industries in southern New Jersey counties allowing higher sulfur fuels providing certain air standards are met. These variances allowed continued plant operations mainly in Salem, Cape May, and Cumberland Counties.

An oil spill law was signed by the Governor in September to provide compensation to beach residents and businesses affected by offshore oil spills that cause onshore damage.

The "Water Pollution Control Act," signed into law by the Governor in late April, established a system of requiring permits intended to control hazardous discharges into the State's water supply. Another water-related bill signed pertains to a plan for water quality throughout the State.

The Public Utilities Commission (PUC) approved a tariff revision for Public Service Electric & Gas Co. (PSE&G) designed to reduce the cost of energy for industry. The revision allows industry to order interruptable electric service for large power, lighting, and high-tension service. Another PUC order, for Atlantic City Electric Co. customers, pertained to denial of electric service to customers with air conditioners using excessive amounts of energy.

In early January, Governor Byrne ordered a ban on all spray-on asbestos after a meeting with the commissioners of schools, health, and environment. Asbestos was sprayed on ceilings and pipes as an acoustical measure in many schools throughout the State. Flaking of asbestos may have caused school children to experience respiratory effects.

On August 13, 1977, the New Jersey DEP adopted new regulations entitled "Control and Prohibition of Air Pollution From Asbestos Surface Coatings" which states that no person shall cause, suffer, allow, or permit surface coating by spraying on any building, structure, facility, installation, or internal or external portion thereof, asbestos or friable material containing in excess of 0.25% asbestos by weight.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland cement into New Jersey totaled 1,335,000 short tons, nearly the same as in 1976. Masonry shipments into New Jersey totaled 56,000 short tons, nearly 4% more than in 1976. Most of the portland and masonry cement was manufactured in eastern Pennsylvania and eastern New York. Cement was distributed from five terminals, two in Jersey City, and one each in Bayonne, Elizabethport, and Newark.

Clays.—The quantity of clay produced increased nearly 11% from 61,549 short tons in 1976 to 68,112 short tons in 1977. Total value was 13% higher and the average unit value of clay increased $0.06 per short ton from $5.37 in 1976 to $5.43 in 1977. Common clay and shale accounted for 76% of the total tonnage and 70% of the value, while fire clay accounted for the remaining 23% of tonnage and 30% of value. Common clay and shale were used for face brick and sewer pipe, whereas fire clay was used for fire brick and block, refractory mortar, and sealing. Common clay and shale were produced in Somerset and Middlesex Counties, and fire clay, in Cumberland and Middlesex Counties. The leading clay producer was New Jersey Shale Brick & Tile Corp. and the leading fire clay producer was J. S. Morie & Son, Inc.

Gem Stones.—Collectors and dealers collected mineral specimens from several localities, refuse areas, and abandoned quarries located principally in the northern part of the State. The value of the material collected was estimated to be $17,000, the same as in 1976.

Graphite (Synthetic).—The Celanese Research Laboratory, Celanese Corp., Summit plant, located in Union County, was the only producer of synthetic graphite within the State. Compared with 1976, value increased nearly 79%. Principal uses for the synthetic graphite were for carbon raisers and for machine and rough shapes.

Gypsum.—National Gypsum Co. and The Flintkote Co. calcined gypsum in Burlington and Camden Counties. Output was used mainly in the manufacture of wallboard, lath, and sheating. Production decreased 15%, but increased more than 6% in value compared with that of 1976.

Iodine.—Consumption of organic and inorganic iodine by eight chemical and pharmaceutical companies consumed 859,520 pounds, a 36% increase compared with that of 1976. Iodine was consumed in manufacture of resublimed iodine, potassium iodide, sodium iodide, and organic iodide containing compounds. Iodine was also used as catalysts, food supplements, stabilizers, in inks and colorants, pharmaceuticals, and sanitary uses.

Lime.—The Limestone Products Corp., Sussex County, was the only producer of lime in the State. Production increased nearly a hundredfold with a corresponding increase in value compared with that of 1976. Lime is used mainly for chemicals, construction, refractories, and agricultural products.

Magnesium Compounds.—Production of magnesium compounds decreased nearly 34% in quantity and more than 52% in value compared with that of 1976. Nationally, New Jersey produced 4.7% of the total quantity compared with 7.1% in 1976. Refractory magnesia was produced in Cape May County by Harbison-Walker Refractories. The major end use for magnesia continued to be the manufacture of refractories. Other uses include fertilizers, pharmaceuticals, production of animal feed, and other chemical processing and manufacturing applications.

Marl, Greensand.—Output of greensand marl decreased nearly 30% in quantity, but increased 13% in value compared with 1976 figures. The marl was produced in Gloucester County and used for water treatment and agricultural purposes.

Peat.—Production of peat increased 12% in quantity, from 26,298 short tons in 1976 to 29,488 in 1977. Total value of peat sold increased 35.4%, but average unit value decreased $0.59 per short ton to $25.49 in 1977. Peat was recovered from bogs near Newton, Stanhope, and Sussex in Sussex County and near Great Meadows in Warren County. Leading producers were Hyper-Humus Co., Mt. Bethel Humus Co. Inc., Netcong Natural Products, and Kelsey Humus & Partac Peat Co. Most of the output was used for general soil improvement with minor use for packing flowers and as an ingredient for potting soil.

Perlite.—Crude perlite was expanded at two plants in Middlesex County. Production and value increased 7.6% and 20%, respectively, compared with 1976 figures. Expanded perlite was used in roof insulation, in plaster and concrete aggregate, in masonry and cavity filler, and as a soil conditioner.

Sand and Gravel.—The total output of sand and gravel declined nearly 22% in quantity and 26% in value compared with that of 1976. Construction sand and gravel accounted for 79% of the quantity and 53% of the value; industrial sand and gravel accounted for 21% of the quantity and 47% of the value. Of the 7,671 thousand short tons of construction sand and gravel sold or used, 36.7% was used for concrete aggregate, 9.7% for concrete products, 7.2% for asphaltic concrete, 10.3% for roadbase and coverings, 29.5% for fill, and the remaining 6.5% for railroad ballast and other uses. Industrial sand was used mainly for molding, abrasives, glass manufacture, and metallurgical purposes. The average unit value of construction sand and gravel was $2.03 per short ton and $6.80 per short ton for industrial sand and gravel. During the year, 63 mines produced sand and gravel in 14 counties compared with 68 mines in 14 counties in 1976.

The leading county was Cumberland with nine mines producing more than 25% of the sand and gravel and nearly 49% of the total value. Other leading counties in declining order of production were Ocean, Morris, Camden, Cape May, and Passaic.

The largest producers of construction sand and gravel are Houdaille Construction Materials, Inc., New Jersey Pulverizing Co., Rite Dun Sand and Gravel Co., Tuckahoe Sand & Gravel Co., and Lockhart Sand Co.

Leading producers of industrial sand and gravel are Pennsylvania Glass Sand Corp., Whitehead Bros. Co., Brimfield Co., South River Sand Co., and J. S. Morie & Son Inc.

Table 4.—New Jersey: Sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	6,577	12,185	5,270	9,961
Gravel	3,023	8,123	2,401	5,590
Industrial:				
Sand	2,819	19,130	2,026	13,775
Gravel	W	W	W	W
Total[1]	12,420	39,439	9,697	29,827

W Withheld to avoid disclosing company proprietary data; included with "Industrial sand."

[1] Data may not add to totals shown because of independent rounding.

Table 5.—New Jersey: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977[1]	
	Quantity	Value	Quantity	Value
Concrete aggregate	2,959	7,271	2,814	6,061
Concrete products	3,384	7,154	747	1,612
Asphaltic concrete	1,265	2,657	556	1,319
Roadbase and coverings	719	1,141	789	1,720
Fill	959	1,002	2,265	3,179
Other uses	312	1,083	303	1,027
Total[2]	9,601	20,309	7,671	15,551

[1] Railroad ballast included in "Total."

[2] Data may not add to totals shown because of independent rounding.

Table 6.—New Jersey: Sand and gravel sold or used, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Atlantic	2	W	W	2	W	W
Bergen	1	W	W	1	W	W
Burlington	3	2,030	4,593	2	W	W
Camden	6	603	1,546	4	1,032	1,983
Cape May	3	582	1,056	5	593	1,090
Cumberland	11	2,765	18,076	9	2,460	14,296
Gloucester	6	84	133	6	132	197
Middlesex	4	644	1,480	4	452	684
Monmouth	3	244	674	3	242	464
Morris	6	1,850	4,038	5	1,191	2,983
Ocean	7	1,820	2,678	8	1,882	3,283
Passaic	6	508	1,883	5	534	1,454
Sussex	8	506	988	7	237	463
Warren	2	W	W	2	W	W
Total	68	12,420	39,439	63	9,697	29,827

W Withheld to avoid disclosing company proprietary data; included in "Total."

Stone.—New Jersey ranked 25th among other States in output of crushed stone, producing nearly 13 million short tons valued at $46.62 million, an increase of 16% in quantity and 19% in value compared with that of 1976. Crushed stone was produced by 23 companies at 30 quarries in 10 counties. Leading stone producers were Traprock Industries, Inc., Stavola Construction Materials Inc., and Mt. Hope Materials Corp. Leading counties in descending order of crushed stone production were Somerset and Passaic. Other counties producing crushed stone in alphabetical order were

Essex, Hudson, Hunterdon, Mercer, Morris, Sussex, Union, and Warren. Unit value of crushed and broken limestone used as agricultural limestone was $8.54 per short ton; dense-graded roadbase, $2.79; filter stone, $8.13; flux stone, $7.97; asphalt filler, $3.30; other filler, $17.56; lime manufacture, $3.10; and other unspecified aggregate, $11.90 per short ton.

The unit price per short ton for crushed granite ranged from $2.59 for concrete aggregate to $5.00 for poultry grit, and the unit price for traprock ranged from $0.89 for fill to $5.64 for asphalt filler. With a production of over 9 million short tons of crushed traprock, New Jersey ranked second in the Nation in crushed traprock production.

Dimension stone was quarried in Hunterdon County by Delaware Quarries and the product used for cut building stone and house stone veneer. Compared with that of 1976, production of dimension stone decreased nearly 7% in quantity and nearly 4% in value even though the unit price increased $2.18 to $71.20 per short ton.

Table 7.—New Jersey: Crushed stone,[1] sold or used by producers by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	4,809	16,010	5,062	18,350
Dense-graded roadbase stone	2,455	8,048	3,057	9,434
Bituminous aggregate	1,810	5,659	2,094	6,775
Concrete aggregate	369	1,068	772	2,167
Macadam aggregate	355	1,269	393	1,260
Surface treatment aggregate	107	341	167	521
Riprap and jetty stone	112	396	150	535
Railroad ballast	W	W	135	387
Filter stone	W	W	28	138
Other uses[2]	1,215	6,219	1,135	7,056
Total[3]	11,234	39,012	12,993	46,621

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes traprock, granite, and limestone.

[2] Includes stone used for roofing granules, agricultural limestone, asphalt filler, other filler, sulfur dioxide (1977), lime manufacture (1977), fill, flux stone, acid neutralization, mineral food, other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Sulfur.—Shipments of byproduct sulfur increased 16% to 126,246 long tons. Value also increased 17% to $5.9 million compared with that of 1976. Elemental sulfur was recovered as a byproduct of petroleum refining at the Mobil Oil Corp. and Texaco, Inc. refineries located in Gloucester County, at the Exxon Co., U.S.A. refinery located in Union County, and at the Chevron Oil Co. refinery in Middlesex County.

Sulfur is used mainly for manufacture of sulfuric acid and fertilizers. Other uses are for plastics, synthetic products, paper products, and explosives.

Vermiculite.—Exfoliated vermiculite was produced by the W. R. Grace & Co. in Mercer County and by The Schundler Co. in Middlesex County from crude vermiculite mined in other States. Exfoliated vermiculite sold or used increased nearly 11% in quantity and 28% in value compared with 1976. The exfoliated vermiculite was used mainly for agricultural purposes, loose-fill insulation, fireproofing, and lightweight concrete aggregate.

METALS

Copper.—AMAX Inc.'s subsidiary, U.S. Metals Refining Co., located at Carteret is the State's largest secondary copper refinery. Principal source materials are copper containing scrap and blister copper from AMAX's operations in other States.[3]

Federated Metals Corp. acquired ASARCO, Inc.'s copper alloy and lead products plants at Perth Amboy, effective April 1, 1977. The plant previously converted metal scrap into continuous cast bronze and brass products and lead pipe and sheet.

Ferroalloys.—Shieldalloy Corp., Newfield, Gloucester County, produced ferroalloys of vanadium, titanium, boron, chromium, columbium, and columbium-nickel.

Iron Ore.—The Mt. Hope mine, the only active underground iron ore mine east of the Michigan-Minnesota area, officially opened on October 26, 1977, shipping to consumers 23,000 long tons of ore valued at over $0.5 million before closing on February 24, 1978. The Mt. Hope mine, located 38 miles from Manhattan, began operating in pre-Revolutionary War times supplying musket shot and cannon balls to General George Washington's Army. Since then, approximately 20 million tons of ore has been produced with an iron content of 58%, being upgraded to 68% after processing. Proven deposits still remain underground with large inferred reserves indicated.

Iron Oxide Pigments.—Metal-base pigments, used primarily in the manufacture of paint, were produced at a number of plants in New Jersey. Production decreased less than 1% from 10,957 short tons in 1976 to 10,917 short tons in 1977, but value increased over 14% from $8.4 million in 1976 to $9.7 million in 1977. Iron oxide pigments were produced in Camden County by Combustion Engineering, C. E. Minerals Div.; in Essex County, by E. I. du Pont de Nemours & Co., Inc., and Sterling Drug, Inc; and in Mercer and Middlesex Counties, by Cities Service Co.

Iron and Steel.—Co-Steel International Ltd., a Canadian concern, located in nearby Toronto, announced in early 1977 plans to build a $95 million steel production facility in Perth Amboy on an 85-acre site of the Raritan Copper Works division of The Anaconda Company which was closed in 1975. Buildings used by Raritan Copper will be razed to make way for a modern electric furnace with a first-phase production capacity of 500,000 tons of steel annually using scrap metal as its raw material. Facilities are to be completed in early 1979.

United States Steel's Fairless works, located north of Philadelphia along the Delaware River, produced hot and cold rolled sheets for the automobile and appliance industries, tin plate for the food and beverage industry, rods and wire for the wire products industry, continuous weld pipe for low-pressure transmission systems, bar products for fasteners, forgings, and machine parts, and wire rope for bridge cable, guy wires, elevator, and shovel cables. Fairless also produced replacement ropes for the Comilog monocable aerial ropeway in Africa, the longest in the world. This ropeway traverses one of the richest manganese ore deposits in existence. Track strand for a tramway in Peru was also manufactured at the Trenton plant. Other products produced were guy wire strand for a radio tower in Florida, replacement cables for the Benjamin Franklin bridge that links Philadelphia and Camden, and various cables for the oil drilling industry.

Selenium.—Selenium was produced as a byproduct from two copper refineries in 1976. AMAX Copper, Inc., and The Anaconda Company, Perth Amboy, produced selenium, a byproduct of the electrolytic copper process used mainly for electronic components, ceramics and glass, chemicals, and for other minor uses. Selenium is also used in rectifiers, photoelectric cells, and other electronic components. Small portions of selenium, when added to glass melts, neutralize the green coloration caused by iron, while larger amounts produce gray and bronze-tinted window glass that reduces glare and heat transmission.

Tellurium.—Tellurium was produced by AMAX Copper, Inc., in Cataret, and The Anaconda Company, in Perth Amboy, with production increasing 63% over that of 1976. The major uses of tellurium were for mold dressing and cast iron products, for improvement of machinability of some low-carbon steels and high-strength alloy steels, and for use in various chemicals. Tellurium is commercially recovered principally from the precious metal-rich anode slimes obtained from the electrolytic refining of copper.

Titanium.—The quantity and value of ilmenite increased 23% in quantity and 33% in value compared with 1976. Glidden-Durkee div., SCM Corp. recovered ilmenite from a sand deposit near Lakehurst, Manchester, and Jackson Townships, Ocean County. The total potentially economic reserves in this area are estimated to be greater than 15,000 acres although residential development will probably affect production of the sands that have a mined concentration of 3% for depths to 25 feet and occasionally the concentration may be found to depths of 80 feet or more. Smaller areas of ilmenite ore with mineral concentration less than the Lakehurst area are located near Browns Mills and Medford Lakes, Burlington County. Another titanium producer is American Smelting and Refining Co. which began shipping ilmenite from its new suction dredging system near Lakehurst. The dredged sand is upgraded to a 63% titanium dioxide concentrate in two successive melting stages. A third unnamed company has completed preliminary drilling tests to determine feasibility of ilmenite production in the Lakehurst area. Ilmenite, an ore containing titanium dioxide, is used in the manufacture of paints, paper, rubber, and leather products.

Zinc.—New Jersey ranked sixth nationally in the production of zinc, behind Missouri, Tennessee, New York, and Colorado, producing 33,464 short tons or 66.9 million pounds valued at $23 million, a decrease of 1% in quantity and 8% in value compared with that of 1976. Unit prices of zinc in 1977 were $0.3440 per pound or $668 per ton. Zinc was produced only in Sussex County, the ore crushed and shipped directly to a company-owned smelter at Palmerton, Pa., where zinc and manganiferous residue were recovered. Zinc is used primarily for galvanizing, brass products, and zinc-base alloys.

MINERAL FUELS

Natural Gas.—Although the State's worst natural gas shortage occurred during the past winter, the gas companies are claiming they are developing new gas surpluses and have requested the PUC for permission to expand services. In early June the PUC allowed two north Jersey natural gas companies to expand services to additional customers, but delayed action on requests filed by the gas companies serving the southern part of the State. At yearend the PUC allowed three of New Jersey's gas distribution companies to serve additional customers while the fourth gas company was given permission to increase service to present customers.

Petroleum.—The Department of the Interior's first mid-Atlantic Outer Continental Shelf (OCS) No. 40 sale resulted in 93 tracts comprising 529,466 acres being leased to companies planning to drill for oil and gas off the New Jersey coast. The U.S. Geological Survey estimates a minimum of 400 million barrels and a maximum of 1.4 billion barrels of oil in the Baltimore Canyon. Exxon Corp. plans to be the first company to begin drilling for oil in early 1978 in an area approximately 95 miles east of Atlantic City. Additional acreage consisting of over 700,000 acres in the Baltimore Canyon, identified as OCS sale No. 49, with leasing rights, will be available in early 1979.

U.S. Coast Guard statistics show that 41,213 gallons of oil from 163 separate spills entered the waters of the Delaware Bay, Delaware River, and south Jersey shore locations during the first half of 1977. The figures represent a 94% decrease from the 667,236 gallons spilled during the second half of 1976. In early February the Bouchard Barge No. 105 backed away from a pier at the Chevron Oil Co. terminal, rupturing two tanks causing loss of 200 gallons of oil into Raritan Bay. In late August a mysterious weekend oil spill in the Brigantine-Atlantic City area occurred. Approximately 200 gallons of oil were cleaned from the ocean surface before damage was done to the beach area. U.S. Coast Guard statistics indicate approximately 80% of all oil pollution is intentional, the result of crewmen cleaning their tanks and dumping the polluted water into the ocean. During the year the Governor signed into law a bill providing assistance to business and industry affected by oil spills.

A report by DEP titled "The Coastal Management Strategy" is a study of the 1,376 square miles of New Jersey coastal region regulated under the Coastal Area Facilities Review Act (CAFRA). This study forms the basis of State regulations of development along the coast from Sandy Hook to Cape May and northward on the Delaware Bay to the Delaware Memorial Bridge.

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[1] State Liaison Officer, Bureau of Mines, Harrisburg, Pa.
[2] Wall Street Journal. September 9, 1977.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Fire:			
J. S. Morie & Son, Inc	Box 35 Mauricetown, NJ 08329	Pit	Cumberland.
Miscellaneous:			
New Jersey Shale Brick & Tile Corp	Box 490 Somerville, NJ 08876	Plant	Somerset.
Gypsum, calcined:			
Jim Walter Corp	No. 1 River Rd. Edgewater, NJ 07020	do	Bergen.
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	do	Burlington.
The Flintkote Co	480 Central Ave. East Rutherford, NJ 07073	do	Camden.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Ilmenite:			
ASARCO, Inc	Rt. 70, Mile 41 Lakehurst, NJ 08733	Plant	Ocean.
Glidden-Durkee Div., SCM Corp	Box 5 Lakehurst, NJ 08733	do	Do.
Iron oxide pigments (manufactured):			
Cities Service Co	380 Madison Ave. New York, NY 10017	do	Mercer and Middlesex.
Combustion Engineering C.E. Minerals Div	901 East 8th Ave. King of Prussia, PA 19406	do	Camden.
E. I. du Pont de Nemours & Co. Inc	DuPont Bldg., D 10084 Wilmington, DE 19898	do	Essex.
Magnesium compounds:			
Harbison-Walker Refractories, a division of Dresser Industries.	2 Gateway Center Pittsburgh, PA 15222	do	Cape May.
Marl, greensand:			
Inversand Co	226 Atlantic Ave. Clayton, NJ 08312	Pit	Gloucester.
Peat:			
Hyper-Humus Co	Lafayette Rd. Box 267 Newton, NJ 07860	Bog	Sussex.
Kelsey Humus and Partac Co	Kelsey Park Great Meadows, NJ 07838	Bog	Warren.
Mt. Bethel Humus Co., Inc	315 West 57th St. New York, NY 10019	Bog	Sussex.
Netcong Natural Products	738 Route 10 Randolph, NJ 07801	Bog	Do.
Perlite (expanded):			
Grefco, Inc	3450 Wilshire Blvd. Los Angeles, CA 90010	Plant	Middlesex.
The Schundler Co	Box 251 Metuchen, NJ 08840	do	Do.
Sand and gravel:			
Brick-Wall Corp	Route 70 Lakehurst, NJ 08733	Pit	Ocean.
Houdaille Construction Materials, Inc	10 Park Pl. Morristown, NJ 07960	Pit	Morris, Ocean, Warren.
J. S. Morie & Son, Inc	Box 35 Mauricetown, NJ 08329	2 Pits and 2 dredges.	Cumberland.
New Jersey Pulverizing Co	115 Hickory Lane Bayville, NJ 08721	Pit	Ocean.
New Jersey Silica Sand Co	Millville, NJ 08332	Dredge	Cumberland.
Pennsylvania Glass Sand Corp	Berkley Springs, WV 25411	Pit	Do.
Saxon Falls Sand & Gravel Co. Inc	R.D. 3 Stanhope, NJ 07874	Pit	Morris.
Tuckahoe Sand & Gravel Co	Box 101 Tuckahoe, NJ 08250	Pit	Cape May.
Warner Co	1721 Arch St. Philadelphia, PA 19103	Dredge	Burlington.
Whitehead Brothers Co	60 Hanover Rd. Florham Park, NJ 07932	Pit and dredge	Cumberland.
Stone:			
Granite, crushed and broken:			
Anthony Ferrante & Sons, Inc	Rt. 202, Mine Brook Rd. Bernardsville, NJ 07924	Quarry	Hunterdon and Somerset.
Hamburg Quarry, Inc	Route 23 Hamburg, NJ 07419	do	Passaic.
Tri County Asphalt Corp	Route 15 Hopatcong, NJ 07843	do	Sussex.
Traprock (basalt), crushed and broken:			
Anthony Ferrante & Sons, Inc	Rt. 202, Mine Brook Rd. Bernardsville, NJ 07924	do	Somerset.
Houdaille Construction Materials, Inc	10 Park Pl. Morristown, NJ 07960	do	Hunterdon, Passaic, Somerset, Union.
Mt. Hope Materials Corp	R.D. 1 Wharton, NJ 07885	do	Morris.
Trap Rock Industries, Inc	Laurel Ave. Kingston, NJ 08528	do	Hunterdon, Mercer, Somerset.
Sulfur (recovered):			
Chevron Oil Co	1200 State St. Perth Amboy, NJ 08861	Plant	Middlesex.
Exxon Co., U.S.A	Box 23 Linden, NJ 07036	do	Union.
Mobil Oil Corp	Paulsboro, NJ 08066	do	Gloucester.
Texaco Inc	Eagle Point, Box 52332 Houston, TX 77052	do	Do.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	do	Mercer.
The Schundler Co	Box 251 Metuchen, NJ 08840	do	Middlesex.

The Mineral Industry of New Mexico

By Herman W. Sheffer[1]

Mineral production in New Mexico continued to rise to a new record high in 1977, reaching a total value of nearly $2,911 million, an increase of 16% over that of 1976. The high increase in the value of minerals produced is mainly a reflection of increased prices, since quantity of production increased for only three more mineral commodities than the number for which production decreased. In 1977, New Mexico ranked eighth in the Nation in total mineral production value. New Mexico continued to produce a broad variety of minerals including fuels, metals, and nonmetals, and the industry comprised a major sector of the State's economy. New Mexico continued to be the leading producer of perlite, potassium salts, and uranium in the United States. The State was also among the leaders in output of copper, helium (high purity), lead, manganiferous ore, mica (crude), molybdenum, natural gas, natural gas liquids, pumice, crude petroleum, silver, tin, and vanadium. Fuels continued to rank first in value of production, accounting for $2,154 million, followed by metals ($528 million), and nonmetals ($229 million). Of the 28 minerals reported produced in New Mexico, 6 accounted for 93% of the total mineral production. These minerals, ranked by value with percentage showing individual share of the total, were as follows: Natural gas (33.5%), petroleum (27.7%), natural gas liquids (9.8%), uranium (8.9%), copper (7.6%), and potassium salts (5.8%).

Table 1.—Mineral production in New Mexico[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide thousand cubic feet	856,548	$80	W	W
Clays[2] thousand short tons	56	116	69	$113
Coal, bituminous do	9,760	W	11,083	87,952
Copper (recoverable content of ores, etc.) short tons	172,360	239,925	164,698	220,037
Gem stones	NA	210	NA	170
Gold (recoverable content of ores, etc.) troy ounces	15,198	1,905	13,560	2,011
Gypsum thousand short tons	W	W	182	1,227
Manganiferous ore (5% to 35% Mn) short tons	45,362	W	29,120	W
Mica (scrap) thousand short tons	W	W	14	W
Natural gas million cubic feet	1,230,976	695,501	1,202,973	974,408
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels	9,490	51,369	44,916	286,299
Liquefied petroleum gases do	32,654	180,577		
Peat thousand short tons	--	--	2	55
Perlite do	481	8,403	521	9,543
Petroleum (crude) thousand 42-gallon barrels	92,130	814,419	87,223	805,065
Potassium salts thousand short tons	2,083	165,354	2,085	169,616
Pumice do	486	1,560	457	1,835

See footnotes at end of table.

Table 1.—Mineral production in New Mexico[1] —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel thousand short tons	7,702	$16,671	8,604	$17,685
Silver (recoverable content of ores, etc.) thousand troy ounces	892	3,880	918	4,242
Stone:				
Crushed thousand short tons	1,921	4,289	1,950	4,785
Dimension do	14	105	17	106
Tin metric tons	W	W	--	--
Uranium (recoverable content of U_3O_8) thousand pounds	11,880	191,271	13,167	260,037
Combined value of cement (masonry and portland), fire clay, helium (high-purity), lead, lime, molybdenum, salt, vanadium, zinc, and values indicated by symbol W	XX	134,492	XX	65,617
Total	XX	2,510,127	XX	2,910,804
Total 1967 constant dollars	XX	902,391	XX	[p]1,436,773

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes fire clay; included with "Combined value" figure.

Table 2.—Value of mineral production in New Mexico, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Bernalillo	$21,012	$28,506	Cement, sand and gravel, stone, clays.
Catron	W	W	Sand and gravel, silver, gold, salt, stone, copper, lead, zinc.
Chaves	20,387	561	Sand and gravel.
Colfax	W	W	Sand and gravel, stone.
Curry	W	W	Sand and gravel.
De Baca	W	175	Do.
Dona Ana	1,306	1,855	Sand and gravel, pumice, stone, clays.
Eddy	539,694	160,688	Potassium salts, salt, sand and gravel.
Grant	259,705	241,916	Copper, zinc, silver, lime, gold, lead, molybdenum, stone, manganiferous ore, sand and gravel.
Guadalupe	W	W	Stone, sand and gravel.
Harding	80	W	Natural carbon dioxide.
Hidalgo	591	399	Stone, sand and gravel, clays, silver, gold, copper, lead.
Lea	903,403	W	Potassium salts, sand and gravel, stone.
Lincoln	133	W	Stone, sand and gravel.
Luna	W	W	Sand and gravel, clays, stone.
McKinley	190,047	178,664	Uranium, stone, vanadium, molybdenum.
Mora	W	3	Sand and gravel.
Otero	474	504	Sand and gravel, stone.
Quay	W	W	Sand and gravel.
Rio Arriba	113,187	W	Pumice, sand and gravel, stone.
Roosevelt	19,048	W	Stone.
Sandoval	5,043	1,190	Gypsum, peat, sand and gravel, pumice.
San Juan	283,764	W	Sand and gravel, helium, pumice, clays.
San Miguel	96	396	Sand and gravel.
Santa Fe	1,202	W	Sand and gravel, pumice, gypsum.
Sierra	W	W	Gold, sand and gravel, silver, lead.
Socorro	W	1,350	Perlite, sand and gravel, stone, lead, pumice, silver, gold.
Taos	41,254	37,486	Molybdenum, perlite, mica, sand and gravel, stone, pumice.
Torrance	204	163	Sand and gravel, stone.
Union	W	W	Pumice, sand and gravel.
Valencia	79,154	W	Uranium, sand and gravel, perlite, stone.
Undistributed[3]	30,344	2,256,944	
Total[4]	2,510,127	2,910,804	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Los Alamos County is not listed because no production was reported.

[2]The value of petroleum is based on an average price per barrel for the State.

[3]Includes some sand and gravel, natural gas (1977), natural gas liquids (1977), petroleum (1977), and coal (1977) that cannot be assigned to specific counties, gem stones and values indicated by symbol W.

[4]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of New Mexico business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force .... thousands..	466.0	503.0	+7.9
Unemployment .... do....	43.0	39.0	-9.3
Employment (nonagricultural):			
Mining .... do....	21.5	23.4	+8.8
Manufacturing .... do....	30.3	32.1	+5.9
Contract construction .... do....	26.1	30.5	+16.9
Transportation and public utilities .... do....	23.4	24.7	+5.6
Wholesale and retail trade .... do....	90.4	95.4	+5.5
Finance, insurance, real estate .... do....	17.0	18.2	+7.1
Services .... do....	73.3	79.7	+8.7
Government .... do....	108.0	110.8	+2.6
Total nonagricultural employment .... do....	390.0	414.8	+6.4
Personal income:			
Total .... millions..	$6,209	$6,970	+12.3
Per capita	$5,298	$5,857	+10.6
Construction activity:			
Number of private and public residential units authorized	8,348	13,667	+63.7
Value of nonresidential construction .... millions..	$116.2	$110.1	-5.3
Value of State road contract awards .... do....	$46.3	$65.0	+40.4
Shipments of portland and masonry cement to and within the State thousand short tons..	559	636	+13.8
Mineral production value:			
Total crude mineral value .... millions..	$2,510.1	$2,910.8	+16.0
Value per capita, resident population	$2,149	$2,446	+13.8
Value per square mile	$20,631	$23,925	+16.0

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

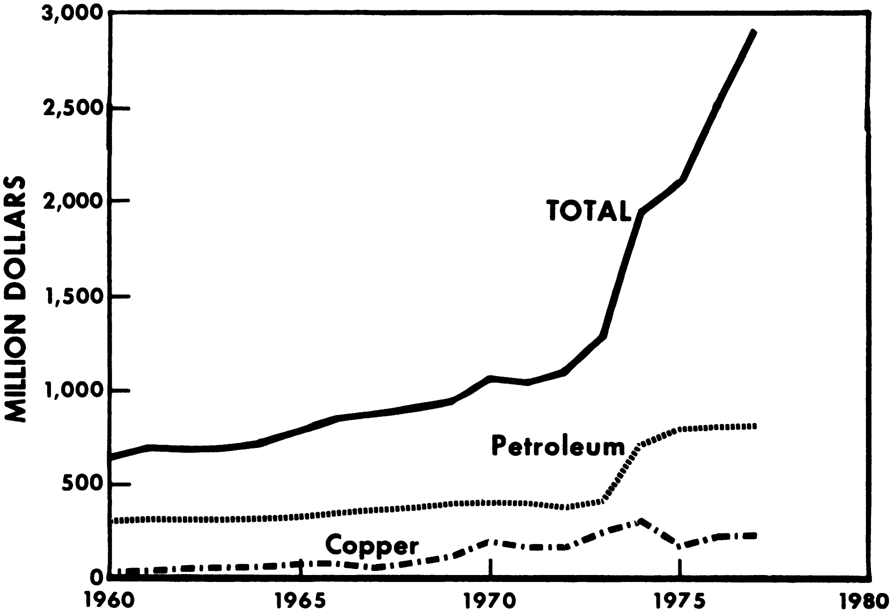

Figure 1.—Value of copper, petroleum, and total value of mineral production in New Mexico.

Mining operations were located throughout the State, but most of the petroleum and natural gas was produced in the southeastern and northwestern parts. Copper was produced principally in the southwestern corner of the State, uranium was mined and processed in the west-central part of the State, potash was mined and processed in the southeastern part, and most of the molybdenum and perlite was produced in the north-central part of New Mexico. Coal was mined and used to generate electricity in the northwestern part of the State; additional coal for use in steelmaking was mined in the northeastern part of the State.

New Mexico was a significant supplier of raw materials to other States. Many of the mineral commodities mined in New Mexico are processed or refined out of State, and most of the mineral products are consumed out of State. Two coal-burning power generation plants, 2 copper smelters, 1 cement plant, 7 potash refineries, 8 oil refineries, and 39 natural gas processing plants are located within the State.

Several events in the mining industry of New Mexico during 1977 were significant. The Hidalgo Copper Smelter of Phelps-Dodge Corp. was operated for the first full year and processed concentrates from the company's Tyrone operation, plus concentrates from Cyprus Bagdad Co. in Arizona. Environmental Research and Technology of Ft. Collins, Colo., began a baseline study for Exxon Minerals to assess the effects of an underground mine in the area of Pinos Altos. United Nuclear Corp. began operating its new uranium mill near Church Rock in May. Sohio Petroleum Co. began operations at its $18 million uranium mill on the L-Bar Ranch near Seboyeta. The Anaconda Co. and United Nuclear Homestake Partners filed applications with the State Environmental Improvement Agency for 5-year renewals of their State licenses to handle radioactive materials. Phillips Petroleum Co. bid $237,766 for a 640-acre uranium lease tract 18 miles northeast of Crownpoint in McKinley County. Quintana Minerals Corp. of Tucson delayed opening its open-pit copper mine near Hillsboro because of depressed copper market conditions, Beker Industrial Corp. closed its anhydrous ammonia plant near Carlsbad in November because of the increased cost of natural gas, and there was a temporary setback in late June at the Questa mine of Molycorp., Inc., when a mudslide damaged the electricity-generating plant. A project was started to install coal-burning facilities and a third finish mill at the Tijeras cement plant of Ideal Basic Industries, Inc. There were notable increases in the production of cement, clays, gypsum, lead, salt, sand and gravel, uranium, and zinc with appreciable decreases in the production of gold, high-purity helium, manganiferous ore, molybdenum, and vanadium.

Legislation and Government Programs.—Environment and energy continued to be the focal points of government activities related to the mineral industry of New Mexico.

The Energy Research and Development Administration (ERDA), succeeded by the Department of Energy (DOE) on October 1, 1977, continued work on its waste isolation pilot plant (WIPP) project near Carlsbad. The objective of the project is to provide the Federal Government with experimental data and practical pilot plant experience in storing low- and intermediate-level radioactive and transuranic defense waste in bedded salt deposits. A preliminary draft Environmental Impact Statement (EIS) was circulated for review within the governmental agencies. However, near yearend, the Secretary of DOE advised the Nuclear Regulatory Commission that his department would be applying for a license to handle high-level commercial radioactive waste. This change necessitated an expanded EIS, which will require more time. Furthermore, a request to the Secretary of the Interior requesting land withdrawals in the Carlsbad area was withdrawn because DOE planned to seek Congressional authorization instead.

The Secretary of the Interior approved a contract on January 14, 1977, between the Navajo Tribe and the Exxon Corp., whereby the Tribe agreed to let Exxon prospect for uranium over 400,000 acres on the reservation near Shiprock and to lease 51,200 acres of that area for mining. A $6 million bonus was paid by Exxon to the Tribe, and the Bureau of Indian Affairs estimated that the project would mean $400 million in new income sources for the Navajos should it be successful. Exxon milling operations could begin by mid-1984 and as many as 1,146 workers could be employed when all projected mines are operational. The Bureau of Mines prepared a financial analysis to determine if, on the basis of the terms of the agreements, there are any inequitable financial consequences. The analysis concluded that there would be substantial dollar benefits to the Tribe and that risk would be minimal.

The Forest Service of the U.S. Department of Agriculture completed an inventory of roadless and undeveloped areas in the national forests and grasslands of New Mexico as part of its Roadless Area Review and Evaluation II program. The inventory includes approximately 464,000 acres in seven major areas of the State. U.S. Bureau of Mines representatives met with Forest Service representatives in Denver, Colo., during December to discuss mineral occurrences or mineral potential on each individual area.

During 1977, three resources and reserve studies were made for ERDA. The U.S. Bureau of Mines completed an economic recoverability study entitled "Valuation of Potash Occurrences Within the WIPP Site in Southeastern New Mexico." Sipes, Williamson & Aycodo, Inc., reported estimates of hydrocarbon potential in the WIPP site, and the U.S. Army Corps of Engineers completed an evaluation of hydrocarbon and potash leases held by private firms in the WIPP site.

The U.S. Bureau of Mines awarded grants during the year to two organizations within the State as follows:

1. $14,450 to the New Mexico Bureau of Mines and Mineral Resources for a project entitled "Copper Leaching Practices in the Western United States;"
2. $19,137 to the New Mexico Bureau of Mines and Mineral Resources for a project entitled "Column Leaching of Low-grade Chalcopyrite Ores Using Thermophilic Bacteria;"
3. $21,000 to the Technology Application Center, University of New Mexico, for a project entitled "Use of LANDSAT Imagery in the Monitoring of Surface Mining."

The U.S. Department of the Interior began preparing a regional environmental impact statement for the coal-rich area near Crownpoint with completion scheduled for July 1, 1978. Decisions relative to the leasing of Federal land, plant siting, railroad locations, land exchanges, and other actions associated with coal development are dependent on completion of the EIS.

A U.S. Department of the Interior task force was formed for the San Juan Basin Regional Uranium Study. The overall study could be later appended to site-specific impact statements. The lead agency is the Bureau of Indian Affairs, and other departmental agencies provide manpower and resources for the study. The report will provide an expert synthesis of available information for decisionmakers in government and industry, tribal groups, self-interest groups, environmentalists, EIS writers, and the general public.

The U.S. Department of the Interior was represented by the Bureau of Mines Liaison Officer on the New Mexico Statewide 208 Policy Advisory Committee. The committee members were appointed by the Governor and were concerned with non-point-source discharge of waters into the State's streams and rivers.

The New Mexico Legislature created the Department of Energy and Minerals by Law 1977, Chapter 355. Six existing State agencies were combined into a single department with broad responsibilities for research, development, and regulation in the energy area. Approximately 120 people operating on a budget of $3 million will be used in 5 divisions of the department. The five divisions are (1) administrative services, (2) energy conservation, (3) energy resource and development, (4) oil conservation, and (5) mining and minerals. Within the Mining and Minerals Division, a Geology Bureau, a Mine Inspection Bureau, and a Surface Mining Bureau will assume functions presently assigned to the agency from which the division was derived. The Geology Bureau will be responsible for studies of energy reserves in the State. The New Mexico Bureau of Mines and Mineral Resources will continue to operate under the supervision of the Board of Regents of the New Mexico Institute of Mining and Technology; however, it will be attached to the Mining and Minerals Division for liaison purposes. The Mine Inspection Bureau will carry out all of the responsibilities of the present State Mines Inspector to insure the safety of mining and milling operations throughout the State. The Surface Mining Bureau will provide staff support for the Coal Surface Mining Commission, which presently hires a consultant to inspect reclamation activities of the coal mines in the State to ensure compliance with the commission's regulations. Enactment of Federal strip mining legislation necessitated the expansion of New Mexico's program to adopt standards and enforcement policies consistent with the more stringent requirements of the Federal Coal Surface Mining Control and Reclamation Act of 1977, Public Law 95-87.

The New Mexico State Legislature passed

the Severance Tax Act in March 1977 to impose a unified system of severance taxes upon the severance of energy resources in the form of oil, gas, coal, and uranium, taking into account the quantity of energy producible in addition to the value of the product or natural resource.

In January 1977, the New Mexico Water Quality Control Commission approved new ground-water pollution regulations designed to protect subsurface water resources. The regulations were designed to set numerical standards for ground-water quality and to limit contaminant concentrations in discharges into ground water.

The New Mexico Coal Surface Mining Commission recommended to Governor Apodaca that the regulation of strip mining be turned over to the Office of Surface Mining in the U.S. Department of the Interior. Formal action by the State legislature is required to revise State regulations to conform with the more strict Federal guidelines.

The Governor of New Mexico signed a cooperative agreement with the U.S. Department of the Interior on January 5, 1977, whereby the State would inspect reclamation of coal-mining operations conducted on Federal land. The agreement became effective on May 1, 1977, and two coal-mining operations, those of Pittsburg and Midway Coal Co. and of Western Coal Co., were being conducted on Federal land as of that date.

The New Mexico Coal Surface Mining Commission continued to administer the State Mining Reclamation Law. Examinations of reclamation progress at all coal strip mines were made three times during the year.

Papers relating to the Mineral Industry of New Mexico were published by the U.S. Bureau of Mines,[2] the U.S. Geological Survey,[3] and the New Mexico State Bureau of Mines and Mineral Resources (a division of the New Mexico Institute of Mining and Technology).[4]

The number of geothermal, mining, and oil and gas leases on Federal lands in New Mexico decreased to 14,634, totaling 10,506,608 acres,[5] approximately 40% of the federally owned acreage in the State and nearly 14% of the total area in the State. In 1977, there were 87 geothermal leases, 161 mining leases, and 14,386 oil and gas leases. Most of the mining leases were for coal and potash. Geothermal leases amounted to 156,294 acres, mining leases amounted to 227,531 acres, and oil and gas leases amounted to 10,122,783 acres.

Employment and Safety.—The New Mexico Mining Industry employed nearly 24,000 people, exclusive of clerical personnel, indicating that slightly more than 8,000 people were employed in exploration, administration, and sales in addition to those listed below in production categories. The 1977 Annual Report of the State Inspector of Mines listed employment in the mining industry, by categories of activity, as follows:

	Coal	Metals	Non-metals	Sand and gravel	Other	Total
Surface	828	3,057	593	517	--	4,995
Underground	271	3,551	1,616	--	--	5,438
Mill or plant	(1)	327	193	421	3,313	4,254
Other	(1)	535	271	97	277	1,180
Total	1,099	7,470	2,673	1,035	3,590	15,867

[1] Included in surface category.

Employment in the mining industry is expected to double by 1985 as the result of large planned developments in the coal, uranium, and power generation sectors.

More than 19,000 men and women were employed in the petroleum industry in New Mexico during 1977. Approximately 900 people were employed in the State's eight petroleum refineries.

During 1977, the metal and nonmetal mining industries experienced an accident frequency rate of 26.95 and 21.92 per million employee-hours worked, respectively, compared with 23.63 and 19.61 in 1976. The severity rate per million employee-hours worked for the same periods was 4,004 and 1,634, respectively, compared with 2,892 and 4,206 in 1976. The mining industry as a whole experienced 646 lost-time accidents, 12 of which were fatal. Coal mining experienced 21 lost-time accidents and no fatal accidents.

During 1977, active central mine rescue stations were located in Carlsbad, Grants, and the Silver City-Vanadium area.

The State Inspector of Mines and his deputies performed 1,090 mining inspections for safety during the year. Federal Mining Safety and Health Administration (MSHA) personnel monitored and assisted the State Inspector of Mines. MSHA personnel also investigated and wrote reports on 11 fatal and no nonfatal accidents and investigated 2 natural deaths that occurred on mining property. As of yearend 1977, 248 metal and nonmetal mines and 5 coal mines were active in New Mexico.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

New Mexico remained a major producer of mineral fuels and was a significant supplier of energy to other States during 1977. Mineral fuels comprised 74% of the State's mineral output in terms of value and amounted to nearly $2.2 billion. Only petroleum decreased in value during 1977 and the value of mineral fuels, which represents a large proportion of the total mineral commodities produced in the State, is shown in the tabulation below.

	1977 value (thousands)	Percent of mineral fuels value	Percent of total minerals value
Natural gas	$974,408	45.2	33.5
Crude petroleum	805,065	37.4	27.7
Natural gas liquids	286,299	13.3	9.8
Coal	87,952	4.1	3.0
Total	2,153,724	100.0	74.0

The petroleum industry continued to be the greatest single source of tax revenues for the State, and receipts from oil and gas production in 1977 ranked third among the State's General Fund revenue sources. Nearly $78 million was paid to the State Land Office as royalties, rentals, and bonuses. Over $37.7 million, or nearly 95% of the total amount paid by the Federal Government to New Mexico through the Federal Mineral Leasing Act, is derived from leasing Federal lands for oil and gas activity.

Coal.—Coal production of more than 11 million tons increased by 1.3 million tons from that of 1976 due chiefly to an increase in demand for steam coal. Production will continue to increase if planned coal-burning and gasification projects become realities. Coal was produced at one strip mine and one underground mine in Colfax County, two strip mines in McKinley County, and two strip mines in San Juan County.

Natural Gas.—Production of natural gas decreased slightly more than 2% in 1977 compared with that of 1976. Value of production, however, increased 40% as the average price of natural gas rose to $0.81 per thousand cubic feet. New Mexico ranked fourth among the 50 states in the production of natural gas.

Natural Gas Liquids.—Production of natural gas liquids increased 6.6% to 44.9 million barrels and increased in value 23.4% to $286.3 million.

Petroleum.—Production of petroleum in the State declined for the eighth consecutive year (5.3% less than in 1976), and for the first time crude petroleum was second to natural gas as the largest single source of mineral value in New Mexico. Value of petroleum output decreased 1.1% from that of 1976. The petroleum industry was the State's principal source of tax revenue and the largest nongovernmental employer.

Output of crude petroleum totaled 87.2 million barrels valued at $805 million. New Mexico ranked sixth among crude petroleum producing States in the Nation.

METALS

The value of metal production increased to $528 million, 9.5% greater than the $482 million in 1976. Principal cause of the increase was a substantial (36%) rise in the value of uranium oxide. Uranium production increased but demand for copper remained depressed and worldwide copper inventories continued to climb to record levels. Uranium surpassed copper for the first time as the principal metal produced, accounting for 49% of the total metal value in the State. Copper value was nearly 42% of the total metal value. Other metals produced in New Mexico in 1977 were gold, lead, manganiferous ore, molybdenum, silver, vanadium and zinc.

Copper.—Total copper production in 1977 declined 7,662 tons and nearly $20 million in value from that of 1976. The State, however, continued to rank third in total copper production behind Arizona and Utah. Three mines in Grant County and one mine in Hidalgo County produced copper as the primary metal. Three other companies in Grant County and one company in Catron County produced copper as a byproduct from other metal mining and by leaching. The Chino mine of Kennecott Copper Corp. near Santa Rita and the Tyrone mine of Phelps-Dodge Corp. near Tyrone, both in Grant County, were the leading copper-producing facilities in the State.

Ore production at the Chino mine of Kennecott Copper Corp. increased slightly to 20,700 tons per day in 1977, with acquisition of a new power shovel and improved production procedures. The company brought online a new precipitate plant located near the new Lampbright waste dump to take advantage of lower-cost copper found in the waste dump material. Additional experience was gained at the Hurley smelter during the year in operating the supplementary and quality control system efficiently in accordance with environmental requirements. Smelter operations were also improved during the year. More than 6.8 million tons of ore was mined during 1977, averaging 0.867% copper, and total copper produced from all sources was 57,263 tons compared with 57,202 in 1976.

Phelps-Dodge Corp. produced 82,000 tons of copper anodes in 1977 at its Hidalgo smelter, mainly from concentrates produced at the Tyrone mill, compared with 37,900 tons produced in only the second half of 1976. The smelter was designed from its inception with air-quality control as a major consideration and emission control facilities represent more than $129 million of the cost of the smelter. During 1977 the company at Tyrone mined approximately 71.7 million tons of waste and ore to produce 15.1 million tons of ore that averaged 0.64% copper compared with 71.0 million tons of waste and ore and nearly 15.5 million tons of ore that averaged 0.66% copper in 1976. Additionally, 4,900 tons of recoverable copper was produced by leaching at Tyrone compared with 41,100 tons in 1976.

In 1977, UV Industries milled 2,351,000 tons of ore, producing 86,000 tons of copper concentrate, compared with 2,428,000 tons of ore and 88,900 tons of concentrate in 1976. Ore production in 1977 from underground mines amounted to 664,000 tons assaying 1.66% copper, and from open pit mines, 1,687,000 tons assaying 0.82% copper. Corresponding figures for 1976 were,

Table 4.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated[2] (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold and silver[3]	5	6,478	1,535	30,406	6	25	4
Copper, lead, and zinc[3]	5	24,404,569	11,098	887,749	143,562	W	W
Total	10	24,411,047	12,633	918,155	143,568	W	W
Other lode material: Copper precipitates	3	28,652	--	--	21,130	--	--
Total lode material	10	24,439,699	12,633	918,155	164,698	W	W
Placer	1	--	927	--	--	--	--
Grand total	11	24,439,699	13,560	918,155	164,698	W	W

W Withheld to avoid disclosing company proprietary data.

[1] Detail will not add to totals shown because some mines produce more than one class of material.

[2] Does not include gravel washed.

[3] Combined to avoid disclosing company proprietary data.

Table 5.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing[1]		Material sold or treated (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1975, total	10	--	19,586,150	15,049	$2,430,263	792,050	$3,500,862
1976, total	12	1	25,189,433	15,198	1,904,611	891,932	3,879,905
1977:							
Catron	1	--	681	58	8,602	5,194	23,996
Grant	6	--	24,438,769	12,565	1,863,515	911,482	4,211,045
Hidalgo	1	--	81	6	890	554	2,559
Sierra	1	1	18	928	137,631	422	1,950
Socorro	1	--	150	3	445	503	2,324
Total	10	1	24,439,699	13,560	2,011,083	918,155	4,241,874

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	146,263	$187,801,710	1,931	$830,492	11,015	$8,591,884	$203,155,211
1976, total	172,360	239,925,052	W	W	W	W	255,807,121
1977:							
Catron	(2)	426	(2)	229	(2)	30	33,283
Grant	164,698	220,036,043	W	W	W	W	237,908,937
Hidalgo	(2)	327	(2)	100	--	--	3,876
Sierra	--	--	(2)	264	--	--	139,845
Socorro	--	--	8	4,743	--	--	7,512
Total	164,698	220,036,796	W	W	W	W	238,093,453

W Withheld to avoid disclosing company proprietary data.

[1] Operations at plants leaching runoff water not counted as mines.

[2] Less than 1/2 unit.

Table 6.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Smelting of concentrates	11,098	887,658	143,547	W	W
Direct smelting of:					
Ore	1,535	30,497	20	25	4
Precipitates	--	--	21,131	--	--
Total	1,535	30,497	21,151	25	4
Total lode material	12,633	918,155	164,698	W	W
Placer	927	--	--	--	--
Grand total	13,560	918,155	164,698	W	W

W Withheld to avoid disclosing company proprietary data.

for underground mines, 668,000 tons assaying 1.66% copper, and, for open pits, 1,760,000 tons assaying 0.83% copper. Two mills having a combined capacity of 8,000 tons of ore per day concentrated the ore by crushing, grinding, and flotation methods. Substantial amounts of byproduct magnetite is produced during concentration. As of December 31, 1977, according to the company's annual report, copper ore reserves in the underground mine were estimated at 16,400,000 tons with an average assay of 2.06% copper, and ore reserves at the open pit operations were estimated to be approximately 18,093,000 tons with an average assay of 0.86% copper.

The company also conducted a highly successful exploration program near Bayard, and a second open pit might be opened. Drilling during exploration showed mineralization, and new ore reserves were estimated to be in excess of 10 million tons averaging 0.6% copper. UV Industries also continued exploration on 31,100 acres of land near Pinos Altos, adjacent to property held by Exxon.

Gold.—Production of gold came from six mines operated by six companies in Grant County and from one mine in each of Catron, Hidalgo, Sierra, and Socorro Counties. Most of the production came from Grant County and was a result of byproduct recovery from copper mining. The quantity of gold produced in 1977 was 1,638 troy ounces less but $106,000 more than in 1976. The average price of gold in 1977 was $148.30 per ounce compared with $125.35 in 1976.

Lead and Zinc.—The Ground Hog mine operated by ASARCO, Inc., in Grant County was the leading producer of lead and zinc in New Mexico during 1977. Two other companies in Grant County and one company in Catron County produced lead and zinc. Lead was also produced by one company each in Hidalgo, Sierra, and Socorro Counties. Zinc was not reported produced in any other county of the State.

Production of lead increased 456 short tons (21%) and value increased $612 thousand (60.8%) over that of 1976. The average price of lead produced in New Mexico during the year was $0.307 per pound.

Zinc production increased by 2,520 short tons (20.5%) and value increased by $1.1 million (12%) over 1976 levels. The average price of zinc produced in New Mexico during the year was $0.344 per pound.

Molybdenum.—Principal production of molybdenum came from the Questa mine of the Molybdenum Corp. of America (Molycorp). Similar molybdenum concentrates were produced by Kennecott Copper Corp. as a byproduct at their Hurley copper concentrator. Kerr-McGee also produced a molybdenum byproduct during uranium concentration at its Ambrosia Lake milling operation.

Molycorp, Inc., was merged into Union Oil Co. of California on July 29, 1977. Open pit mining operations at Molycorp's Questa mine is planned during 1978. Stockpiled ore will continue to be processed in the mill to produce molybdenum until 1980. In late 1977, Molycorp dissolved its partnership with Kennecott Copper Corp., and as a result of exploration drilling and feasibility studies, Molycorp is studying the development of a large-scale underground mining operation with production expected to begin in early 1980.

Silver.—Production of silver came chiefly as a byproduct of copper, lead, and zinc mining and processing. Major producers, in order of rank, were Phelps-Dodge Corp., UV Industries, Inc., and ASARCO, Inc., all in Grant County. Other producers in Grant County were Kennecott Copper Corp., Summit Minerals and Dresser Industries, Inc. Silver was also produced by one company each in Catron, Hidalgo, Sierra, and Socorro Counties. Silver production increased 26,000 troy ounces (2.9%) and $362,000 (9.3%) in value over that of 1976. The average price of silver produced in New Mexico during the year was $4.62 per troy ounce.

Uranium.—New Mexico retained its position as the leading producer of uranium in the United States, accounting for 45% of the U.S. total production. Total production of uranium oxide (U_3O_8) amounted to 13,167,000 pounds, recovered from 3,972,411 tons of ore.

Reported production came from 26 mines in McKinley County and 4 mines in Valencia County. The ore was mined by seven companies and processed in three uranium processing mills having a nominal capacity of 13,000 tons of ore per day. The mills, all located in the Ambrosia Lake district in McKinley County, are operated by Kerr-McGee Corp., United Nuclear Corp., Inc., and The Anaconda Company. Most of the ore was processed at the Kerr-McGee mill. The average price of the U_3O_8 (yellowcake) produced during the year was $12.30 per pound.

A U.S. District Judge dismissed a suit

filed by 17 Navajos to prohibit the Department of the Interior Secretary from approving an Environmental Impact Statement regarding a proposed uranium development contract between the Navajo tribe and Exxon Corp. The Navajo tribe in 1974 agreed to let Exxon prospect for uranium over a 400,000-acre area on the reservation and agreed to lease 51,200 acres of that area for mining.

Kerr-McGee Corp. continued exploration for uranium in 1977 at a high level. A significant increase in uranium ore reserves was achieved by concentrated development drilling at Church Rock in the Ambrosia Lake District and in the Marquez area. Uranium production during 1977 increased to approximately 4.6 million pounds of U_3O_8 compared with 4.1 million pounds in 1976. Kerr-McGee also continued to toll-mill ore for other companies. Production came from seven underground mines in the Ambrosia Lake area and from one underground mine near Church Rock. Development work began during the year on a second mine in the Church Rock area and shaft sinking was underway at the Rio Puerco mine located approximately 50 miles east of the Grants mill.

Phillips Petroleum Co. announced plans in March for the company's first major uranium mining operation to be located near Nose Rock in northwest New Mexico. The company plans to sink four 3,400-foot shafts (two for production and two for ventilation) and to start construction of a mill in 1978 to handle initial production of about 2,950 tons per day of uranium ore.

Substantial progress was made during the year at the Johnny M. mine of Ranchers Exploration and Development Corp. The mine had produced about 134,000 pounds of uranium oxide by February and future outputs were expected to increase. During the first quarter of the year, production and ventilation shafts at the Hope mine were completed and production began in the third quarter. About 5,000 tons of uranium ore per month is projected to be produced from the Hope mine.

The $18 million uranium mill of Sohio Petroleum Co. located on the L-Bar Ranch began operations. Production in the mill was about 1,500 tons of ore per day. The mill, designed and constructed by Fluor-Utah, Inc., uses a wet grinding cascade mill whereby most airborne radiation related to dust problems associated with typical crushing circuits is eliminated.

United Nuclear Corp. completed the second production shaft at its Church Rock mine, bringing the mine's total capacity to 3,000 tons per day and making it the largest underground mine in the United States. The company's Church Rock mill was completed in May and was licensed for full operation by the New Mexico Environmental Improvement Agency. The St. Anthony open pit mine in the Laguna district neared completion, and a nearby shaft sinking project continued on schedule. A new production shaft to improve access to the ore body at the Sandstone mine in the Ambrosia Lake district was completed. A substantial new development project in the Dalton Pass area north of Crownpoint was begun on two Navajo lease tracts.

Gulf Minerals produced its first uranium in the United States from the Mariano mine near Grants in October. Although the mine is small and located at a shallow depth of 500 feet, reserves of 3.5 million pounds will be produced over a 4-year period. During 1977, a total of 60,000 pounds of U_3O_8 was produced from the mine's ore that was toll-milled at another company's mill. Development of service and production shafts at Gulf's Mount Taylor mine continued and reached the 2,700-foot level. Pilot mining at 3,300 feet is projected to begin in 1979.

The share of production for Western Nuclear, Inc., from the Ruby No. 1 mine near Grants was 145,300 pounds of U_3O_8 in 1977, compared with 80,400 pounds in 1976 when the mine was still in the development state. Ore from the mine is milled under contract by another company.

The U.S. Department of the Interior began the San Juan Basin Regional Uranium Study to project uranium demand and mining activities in the area from the present to the year 2000. Various bureaus of the department were assigned responsibilities for different chapters of the report, which will address factors such as different forms of fuels and their availability, cost and location; capital investment and its availability; cost of new plants; methods of purchasing plants and fuels; constraints on an operating company such as state agencies, government regulations, and various laws; factors affecting the environment; description of the study area; and present and future scenarios with and without uranium mining.

Other Metals.—Manganiferous ore and vanadium were also produced in New Mexico during 1977. Manganiferous ore production and value decreased from those of 1976. Vanadium production and value decreased substantially from those of 1976.

NONMETALS

Value of nonmetals production increased 6.5% to nearly $229 million and represented nearly 7.9% of the State's total mineral production value. The most valuable nonmetal mineral produced in New Mexico continued to be potash (potassium salts); its share in value of the total nonmetals output was 74%. Other nonmetal minerals produced, in descending order of value, were cement, sand and gravel, perlite, stone, lime, pumice, salt, gypsum, gem stones, mica, clays, helium, carbon dioxide, and peat.

Cement.—Ideal Cement Co., a division of Ideal Basic Industries, Inc., was the State's only cement producer at its plant located at Tijeras, east of Albuquerque in Bernalillo County.

Clays.—Six operations produced clay and shale during 1977. Two mines were operated in Bernalillo County and one mine each was operated in Dona Ana, Hidalgo, Luna, and San Juan Counties. Production of clay increased in 1977 over that of 1976, but value decreased slightly.

Gypsum.—White Mesa Gypsum Co. and Duke City Gravel Products Co. mined gypsum in Sandoval County, and Western Gypsum Co. mined gypsum in Santa Fe County; output increased substantially. American Gypsum Co. calcined gypsum at Albuquerque in Bernalillo County, and Western Gypsum Co. calcined gypsum at its Rosario plant in Santa Fe County.

Lime.—Mathis Mining and Exploration Co. and Kennecott Copper Corp. produced lime in Grant County during the year.

Mica.—Only one mica mine was active in the State during 1977, that of the Mineral Industries Commodities, Inc., located in Taos County.

Peat.—Peat (humus) was produced by Humus Organic Products from a pit located near San Ysidro in Sandoval County.

Perlite.—New Mexico continued to lead the Nation with 87% of total crude perlite production as 1977 production increased by 40,000 tons and value increased by more than $1.1 million. Grefco, Inc., with the El Grande mine, and Johns Manville Perlite Corp. with the Seven Hill mine, both in Taos County, were the two largest producers in the State. Additional production came from Grefco, Inc., from its mine in Socorro County, Silbrico Corp. in Taos County, and United States Gypsum Co. in Valencia County.

Potash.—New Mexico remained the leading producer of potash in the Nation, contributing 85% of total U.S. output in 1977. Seven companies were engaged in potash production in Eddy County, and one company produced potash in Lea County. Total production in New Mexico increased slightly by 2,000 tons. Value of production also increased slightly by 2.6% to nearly $170 million, with the average price of potash rising from $79.38 per ton in 1976 to $81.35 per ton in 1977.

The project initiated in September 1976 by AMAX Chemical Corp. to increase production of premium-priced, granular-grade potash was completed during the year, and a 20% increase in production was anticipated.

Duval Corp. announced the cessation of production of muriate of potash at midyear. Concurrent with the phasing out of muriate production, Duval began expansion of production capacity for K-Mag, the company's premium fertilizer. Extensive langbeinite ore reserves will be exploited to meet the rapidly growing market for the K-Mag product, and production is expected to increase from the present 350,000 tons per year to approximately 500,000 tons per year.

International Minerals & Chemical Corp. produced 230,000 tons of muriate of potash during 1977 plus an additional 640,000 tons of specialty potash. Shipments of potash increased from 755,000 tons in 1976 to 920,000 tons in 1977. Reserves at yearend stood at 229 million tons of ore, enough to support present operations for more than 25 years.

National Potash Co. had a difficult year because low-grade ore sections and a temporary shortage of underground miners resulted in lower-than-anticipated production and higher operating costs. A small loss resulted in 1977 on sales of about 283,000 tons of potash. The company also incurred heavy litigation costs from its successful but burdensome defense of antitrust charges.

Pumice.—In terms of output tonnage, New Mexico ranked fifth in the Nation in the production of pumice,[6] and although production declined slightly from that of 1976, the value increased substantially by

17.6% to more than $1.8 million. During 1977, 11 operations in 8 counties included 12 mines and 9 processing plants. The largest producers in the State were Twin Mountain Rock Co. in Union County, General Pumice Corp. in Rio Arriba County, Morton Brothers in Dona Ana County, and Copar Pumice Co., Inc., in Santa Fe County.

Table 7.—New Mexico: Production and sales of potassium salts

(Thousand short tons and thousand dollars)

Period	Crude salts[1]		Marketable potassium salts				
	Mine production		Production		Sold or used		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value[2]
1976:							
January-June	8,583	1,289	1,876	1,005	2,069	1,098	92,744
July-December	8,725	1,271	1,834	984	1,820	985	72,610
Total	17,308	2,560	3,710	1,989	3,889	2,083	165,354
1977:							
January-June	9,305	1,329	1,985	1,027	2,316	1,202	96,991
July-December	9,680	1,374	2,046	1,066	1,696	883	72,625
Total	18,985	2,703	4,031	2,093	4,012	2,085	169,616

[1] Sylvinite and langbeinite.
[2] F.o.b. mine.

Salt.—Salt was produced in various forms and continued to be a major product of the potash industry. A total of five active operations reported production for 1977; four operations were in Eddy County and the fifth operation was in Catron County. Salt production and value increased over that of 1976.

Sand and Gravel.—Production of sand and gravel remained the most widespread mining activity in the State. Sand and gravel was mined by 87 companies at 95 separate operations in 28 counties of the State. No production was reported for Harding, Los Alamos, McKinley, and Roosevelt Counties. Production of sand and gravel increased by more than 900,000 tons and value of production increased 6.1% over that of 1976 to $17.7 million. The average unit value of sand and gravel produced in New Mexico during 1976 was $2.06 per ton. Commercial operations accounted for 6.1 million tons, 71% of the total State output; government operations accounted for the remainder. Most of the sand and gravel produced was used for concrete aggregate, road construction, and asphalt concrete aggregate. More than 95% of all the sand and gravel produced was transported by truck.

Stone.—Stone production increased nearly 2% in quantity and more than 11% in value compared with that of 1976. In 1977, a total of 45 stone quarries were operated in the State by 28 producers. Guillen Construction Co., Rocky Mountain Stone Co., W. H. Thomas Stone Quarry, and Apache Springs Co. quarried dimension stone for rubble, rough construction stone, cut stone, and rough blocks. Output expanded 28% to 17,500 tons valued at $106,300. Crushed stone was produced by 20 companies at 32 quarries for roadbase aggregate, fill, bituminous aggregate, and other uses. Output increased 2% to 1,950,000 tons valued at $4.79 million. Leading producers were R. J. Kern, Kent Nowlin Construction Co., and the State Highway Commission.

Among the States, New Mexico ranked fourth in output of dimension limestone and fifth in dimension miscellaneous stone.

Other Nonmetals.—Carbon dioxide, gem stones, high-purity helium, and sulfur were also produced in New Mexico during 1977. Carbon dioxide was produced by SEC Corp. of El Paso, Tex. at two plants in Harding County, one at Solano and one at Bueyeros. The company recovers carbon dioxide in the form of a gas from wells and pipes the gas to the processing plants. The gas as recovered from the wells is more than 99% CO_2. The gas is converted to a liquid in the plants and is sold either as a liquid or as a solid (dry ice). SEC Corp. is the largest single industry in Harding County. Turquoise, the principal gem stone produced, was sold either as raw or polished turquoise in the State. Western

Helium Co. operated a helium extraction plant in San Juan County. High-purity helium was recovered from a feedstock mixture of nitrogen and helium obtained from the Tocito Field. Elemental sulfur was recovered as a byproduct of natural gas processing at plants located in Eddy, Lea, and Roosevelt Counties.

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[5] Geological Survey, U.S. Department of the Interior.

[6] Statistics designated "pumice" include such volcanic materials as scoria and volcanic cinders.

Table 8.—New Mexico: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	381	674	233	465
Fill	114	171	228	346
Bituminous aggregate	238	535	221	437
Roadstone	128	169	187	312
Lime manufacture	70	W	133	W
Concrete aggregate	W	W	117	220
Flux stone	146	291	W	W
Surface treatment aggregate	104	196	26	147
Filter stone	--	--	4	9
Macadam aggregate	84	84	--	--
Agricultural limestone	4	13	--	--
Other uses[2]	652	2,156	801	2,850
Total	1,921	4,289	1,950	4,786

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, sandstone, traprock, granite, and miscellaneous stone.

[2] Includes stone used for cement manufacture, riprap and jetty stone (1977), railroad ballast (1977), terrazzo and exposed aggregate, and uses indicated by symbol W.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon dioxide (natural):			
S.E.C. Corp	Box 9737 El Paso, TX 79987	Well and extraction plant.	Harding.
Cement:			
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, CO 80202	Dry process, 2-rotary-kiln plant.	Bernalillo.
Clays:			
El Paso Brick Co	Box 12336 El Paso, TX 79912	Open pit mine	Dona Ana.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, CO 80202	do	Bernalillo.
Kinney Brick Co., Inc	Box 1804 Albuquerque, NM 87102	do	Do.
Coal:			
Amcoal, Inc	Box 832 Riverside, CA 92502	Strip mine	McKinley.
Kaiser Steel Corp	Box 58 Oakland, CA 90604	Underground mine, strip mine, crushing plant, dense media-froth flotation cleaning plant.	Colfax.
The Pittsburg & Midway Coal Mining Co.	1600 Tenmain Center Kansas City, MO 64106	Strip mine, crushing plant, chemical and water treatment plant.	McKinley.
Utah International, Inc	550 California St. San Francisco, CA 94104	Strip mine, crushing plant, dust suppression detergent treatment plant.	San Juan.
Western Coal Co	Box 1026 Albuquerque, NM 87103	Strip mine	Do.
Copper:			
Kennecott Copper Corp.,[1] Chino Mines Div.	Hurley, NM 88043	Open pit mine, flotation mill, precipitation plant, smelter.	Grant.
Phelps-Dodge Corp., Tyrone Branch[1]	Drawer B Tyrone, NM 88065	Open pit mine and mill	Do.
UV Industries[2]	136 East South Temple St. Salt Lake City, UT 84111	Underground mine, open pit mine, flotation mill.	Do.
Gypsum:			
Duke City Gravel Products Co	Gun Club Rd., SW. Albuquerque, NM 87105	Open pit mine	Sandoval.
Western Mining Co., Inc	7708 Northridge, NE. Albuquerque, NM 87109	do	Santa Fe.
White Mesa Gypsum Co	124 Jackson, NE. Albuquerque, NM 87108	do	Sandoval.
Lead: ASARCO, Inc	Box 186 Vanadium, NM 88773	Underground mine, shaft.	Grant.
Lime:			
Kennecott Copper Corp., Chino Mines Div.	Hurley, NM 88043	Rotary-kiln plant	Do.
Mathis Mining & Exploration Co	1101 Santa Rita Silver City, NM 88061	Quarry, open pit mine	Do.
Mica:			
Mineral Industries Commodities of America, Inc.	Box 2408 Santa Fe, NM 87501	Open pit mine	Taos.
Molybdenum:			
Molybdenum Corp. of America, Questa Div.	280 Park Ave. New York, NY 10017	Open pit mine and flotation mill.	Do.
Natural gas and petroleum:[3]			
Perlite:			
Grefco, Inc., Dicalite Div	333 North Michigan Ave. Chicago, IL 60601	Open pit mine; crushing, screening, air separation.	Socorro and Taos.
Johns-Manville Perlite Corp	2500 Miguelito Rd. Lompoc, CA 94336	Open pit mine; crushing, screening, air separation.	Taos.
Potash:			
AMAX Chemical Corp	Box 279 Carlsbad, NM 88220	Underground mine, refinery.	Eddy.
Duval Corp., Potash Div	Box 511 Carlsbad, NM 88220	2 underground mines, refinery.	Do.
International Minerals & Chemical Corp.	Box 71 Carlsbad, NM 88220	Underground mine	Do.
Kerr-McGee Corp	Kerr-McGee Bldg. Oklahoma City, OK 73102	do	Do.
Mississippi Chemical Co	Box 101 Carlsbad, NM 88220	1 underground mine	Do.
National Potash Co	Box 731 Carlsbad, NM 88220	do	Do.
Potash Co. of America, a division of Ideal Basic Industries, Inc.	Box 31 Carlsbad, NM 88220	do	Do.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Pumice:			
General Pumice Corp	Box 449 Santa Fe, NM 87501	Open pit mine, crushing and screening plant.	Rio Arriba.
Morton Bros	Box 2000 Las Cruces, NM 88001	do	Dona Ana.
Twin Mountain Rock Co	Box 1009 Sheridan, WY 82801	do	Union.
Salt:			
Potash Co. of America, a division of Ideal Basic Industries, Inc.	Box 31 Carlsbad, NM 88220	Tailings salt	Eddy.
Mississippi Chemical Co	Box 101 Carlsbad, NM 88220	Solar evaporation	Do.
Sand and gravel (commercial):			
Albuquerque Gravel Products	Box 829 Albuquerque, NM 87103	Stationary plant	Bernalillo.
Springer Corp	Box 572 Albuquerque, NM 87103	Pit, stationary crushing and screening plant.	Do.
San Juan Concrete	507 South Behrend Ave. Farmington, NM 87401	Portable plant, crushing plant.	San Juan.
Jones Construction Co	Box 803-A Albuquerque, NM 87103	Portable plants	Sandoval and Santa Fe.
Rose Gravel	1400 San Jose Blvd. Carlsbad, NM 88220	1 stationary and 2 portable plants.	Eddy.
Alcora Materials Co	Box 2439 Farmington, NM 87401	Portable plants	San Juan.
Stone:			
G. F. Atkinson Co	Box W Albuquerque, NM 87103	Quarry	Sandoval.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, CO 80202	Quarry and plant	Bernalillo.
New Pueblo Constructors, Inc	Box 430 Tijeras, NM 87059	Quarry	Do.
Wylie Brothers Contracting Co	Box 8526 Albuquerque, NM 87108	Open pit	Otero.
Uranium:			
The Anaconda Company, New Mexico Operations.	Box 638 Grants, NM 87020	Open pit mine, acid-leach process mill.	Valencia.
Kerr-McGee Corp	Box 218 Grants, NM 87020	6 underground mines, acid-leach process mill.	McKinley.
United Nuclear Corp	Box 3951 Albuquerque, NM 87110	6 underground mines, alkaline-leach process mill.	Do.

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[1] Also gold, molybdenum, and silver.

[2] Also gold and silver.

[3] Most of the major oil and gas companies operate in New Mexico and several commercial directories contain complete lists of them.

The Mineral Industry of New York

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New York State Museum and Science Service for collecting information on all minerals except fuels.

By Doss H. White, Jr.[1]

In 1977, New York ranked 29th in the Nation in the value of mineral production. Mineral value was reported at $462 million, an increase of $34 million over that of 1976. This was a record high and raised the value of minerals produced in the State during the 1970's to over $3 billion, a figure that was a significant part of the State's economy during this period. New York was an important producer nationally of garnet, ilmenite, and talc; was the leading producer of alumina-zirconia oxide; and was the only United States producer of wollastonite while ranking third in the production of zinc.

Table 1.—Mineral production in New York[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	649	$2,089	564	$1,728
Gem stones	NA	15	NA	15
Lead (recoverable content of ores, etc.) short tons	3,196	1,476	2,778	1,706
Natural gas million cubic feet	9,235	10,436	10,682	12,391
Peat thousand short tons	32	684	39	569
Petroleum (crude) thousand 42-gallon barrels	857	10,497	824	11,701
Salt thousand short tons	6,495	66,441	6,452	72,623
Sand and gravel do	27,881	56,132	29,197	57,570
Silver (recoverable content of ores, etc.) thousand troy ounces	49	214	56	260
Stone thousand short tons	28,136	75,040	29,947	90,781
Zinc (recoverable content of ores, etc.) short tons	73,671	54,517	70,839	48,737
Combined value of cement (masonry and portland), clays (ball), emery, garnet (abrasive), gypsum, iron ore, lime, talc, titanium concentrate (ilmenite), and wollastonite	XX	150,423	XX	163,726
Total	XX	427,964	XX	461,807
Total 1967 constant dollars	XX	219,674	XX	[P]227,948

[P]Preliminary. NA Not available. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes ball clay; value included with "Combined value."

Table 2.—Value of mineral production in New York, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Albany	W	W	Cement, stone, clays, sand and gravel.
Allegany	W	$1,463	Sand and gravel.
Broome	$2,081	W	Sand and gravel, clays, peat.
Cattaraugus	W	4,208	Sand and gravel.
Cayuga	W	W	Sand and gravel, stone.
Chautauqua	8,218	981	Sand and gravel.
Chemung	1,297	878	Do.
Chenango	464	657	Do.
Clinton	W	873	Stone, sand and gravel.
Columbia	10,893	8,266	Cement, sand and gravel, stone.
Cortland	1,061	832	Sand and gravel.
Delaware	W	W	Stone, sand and gravel.
Dutchess	W	W	Stone, sand and gravel, peat.
Erie	14,760	W	Stone, lime, sand and gravel, clays.
Essex	11,721	13,336	Iron ore, titanium concentrates, wollastonite, sand and gravel, stone.
Franklin	W	W	Stone, sand and gravel.
Fulton	401	320	Sand and gravel.
Genesee	W	W	Stone, gypsum, sand and gravel.
Grene	W	W	Cement, stone, sand and gravel.
Hamilton	--	24	Sand and gravel.
Herkimer	W	W	Sand and gravel, stone.
Jefferson	2,008	2,604	Stone, sand and gravel.
Lewis	962	W	Do.
Livingston	W	W	Salt, sand and gravel, stone.
Madison	W	1,453	Stone, sand and gravel.
Monroe	W	W	Do.
Montgomery	1,677	1,619	Do.
Nassau	W	W	Sand and gravel, clays.
Niagara	W	W	Stone.
Onieda	W	W	Stone, sand and gravel.
Onondaga	36,546	45,138	Lime, stone, cement, salt, sand and gravel, clays.
Ontario	W	W	Sand and gravel, stone.
Orange	W	2,763	Sand and gravel, stone, peat, clays.
Orleans	W	W	Stone, sand and gravel.
Oswego	1,335	1,799	Sand and gravel.
Otsego	189	347	Do.
Putnam	W	W	Stone.
Rensselaer	W	W	Sand and gravel, stone.
Rockland	W	W	Stone, sand and gravel.
St. Lawrence	78,169	69,898	Zinc, iron ore, talc, lead, stone, sand and gravel, silver, wollastonite.
Saratoga	2,432	3,225	Stone, sand and gravel.
Schenectady	W	536	Sand and gravel.
Schoharie	W	W	Cement, stone, sand and gravel.
Schuyler	W	W	Salt, sand and gravel.
Seneca	W	W	Stone, sand and gravel, peat.
Steuben	5,552	W	Sand and gravel, stone.
Suffolk	4,798	4,809	Sand and gravel.
Sullivan	W	W	Stone, sand and gravel.
Tioga	1,956	1,245	Sand and gravel.
Tompkins	W	W	Salt, stone, sand and gravel.
Ulster	W	W	Stone, cement, sand and gravel, clays.
Warren	11,284	10,829	Cement, garnet, stone, sand and gravel.
Washington	1,435	1,539	Stone, sand and gravel.
Wayne	W	W	Do.
Westchester	213	305	Sand and gravel, emery, stone, peat.
Wyoming	W	W	Salt, sand and gravel.
Yates	W	330	Sand and gravel.
Undistributed[3]	228,512	281,529	
Total	427,964	[4]461,807	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Bronx, Kings, New York, Richmond, and Queens Counties are not listed because no production was reported.

[2] Value of petroleum and natural gas is based on an average price per barrel and cubic foot, respectively, for the State.

[3] Includes gem stones, sand and gravel, natural gas, petroleum, and values indicated by symbol W.

[4] Data do not add to total shown because of independent rounding.

Table 3.—Indicators of New York business activity

		1976	1977^{p}	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	7,714.0	7,762.0	+.6
Unemployment	do	792.0	708.0	-10.6
Employment (nonagricultural):				
Mining	do	7.1	7.1	--
Manufacturing	do	1,438.9	1,459.2	+1.4
Contract construction	do	189.4	189.9	+.3
Transportation and public utilities	do	428.1	425.4	-.6
Wholesale and retail trade	do	1,416.1	1,425.7	+.7
Finance, insurance, real estate	do	575.3	577.4	+.4
Services	do	1,456.4	1,482.9	+1.8
Government	do	1,267.5	1,259.8	-.6
Total nonagricultural employment	do	6,778.8	6,827.4	+.7
Personal income:				
Total	millions	$125,079	$135,089	+8.0
Per capita		$6,929	$7,537	+8.8
Construction activity:				
Number of private and public residential units authorized		30,476	39,645	+30.1
Value of nonresidential construction	millions	$636.9	$642.9	+.9
Value of State road contract awards	do	$295.0	$500.0	+69.5
Shipments of portland and masonry cement to and within the State	thousand short tons	2,584	2,345	-9.3
Mineral production value:				
Total crude mineral value	millions	$428.0	$461.8	+7.9
Value per capita, resident population		$24	$26	+8.3
Value per square mile		$8,632	$9,315	+7.9

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Legislation and Government Programs.—In 1976, legislation was passed requiring safety standards for design and operation of future liquefied natural gas (LNG) facilities. The New York State Department of Environmental Conservation proposed such standards and instituted hearings for public input on the proposed regulations. Additional work was underway on regulations for existing LNG facilities that do not conform to the proposed standards.

Legislation on natural gas development beneath the State's portion of Lake Erie was passed during the year. Public hearings were scheduled on the proposed development and work was underway on a Federal-State Environmental Impact Statement on the effects of natural gas development in the Lake Erie area.

Mineral resource studies by State and Federal geological surveys were underway on a number of mineral commodities in New York. A reorganized State Geological Survey continued work in a number of mineral related areas. Heavy mineral deposits in the Port Leyden area and high calcium marbles in the Bear Creek drainage area were investigated by the Federal Geological Survey.

The resources of Eastern Ontario-St. Lawrence coastal zone were documented in a report by the Eastern Ontario-St. Lawrence Commission. Funds for the study were provided under Public Law 92-583, the Federal Coastal Zone Management Act.

The New York departments of Transportation and Environmental Conservation initiated studies on county sand and gravel inventories; and the State Geological Survey continued a 3-year project on the natural gas potential of the State's black shale.

Work by a number of State and Federal agencies continued in areas of potential environmental concern. One such dealt with the possible asbestos-type mineral association with selected crushed stone operations. Detailed studies were made on a talc operation in St. Lawrence County where preliminary work suggested that asbestos-type minerals might be associated with the talc. In a second area, studies were underway to determine the effectiveness of shallow burial of low-level radioactive wastes at the West Valley nuclear wastes burial site. Data gathered during the year indicated that the disposal site [illegible]rforming adequately.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives, Manufactured.—Artificial abrasives such as steel shot and grit, cut wire shot, and fused aluminum oxide and silicon carbide were produced by Cleveland Metal Abrasive Co., General Abrasive Co., Exolon Co. and The Carborundum Co. Production by the four firms was at the 1976 level, as all operations were producing at capacity.

Calcium Chloride.—Byproduct calcium chloride was produced during the manufacture of soda ash by Allied Chemical Corp. at the company's Onondaga facility. Calcium chloride is less corrosive than sodium chloride (salt) and has application as a deicing medium.

Cement.—Cement continued to lead all mineral commodities produced in New York in value. Over 95% of the cement produced was portland variety which is the chief binding agent used in concrete and masonry construction. Cement shipments to and within the State decreased from 2.6 million tons reported in 1976 to 2.3 million tons in 1977.

Clays.—Clay and shale used in the manufacture of common brick, pottery, lightweight aggregate, portland cement, and for abrasive bonding was mined in seven counties. Ball clay was produced by one company in Albany County and used for bonding in ceramic ware. Clay production was reported at 564,000 tons valued at $1.7 million. This was a decrease in both tonnage and value from that reported in 1976.

Emery.—The only production of emery in the United States was recorded from two operations in Westchester County. De Luca Emery Mine, Inc., and Emeri Crete, Inc., produced emery for aggregate for heavy duty nonslip floors and pavements, and for general abrasive purposes.

Garnet.—New York ranked second in garnet production in 1977. Barton Mines Corp. operated an open pit mine in Warren County, producing garnet for coated abrasives, glass grinding and polishing, and metal lapping.

Gem Stones.—The collection and sale of mineral specimens and of semiprecious stones was a small but integral part of New York's mineral industry. Value of this segment of the industry was estimated at $15,000.

Graphite.—Synthetic graphite manufactured from petroleum, coke, and coal tar pitch binder was produced by Great Lakes Carbon Corp.; Airco, Inc., Speer Div.; The Carborundum Co., Graphite Products Div.; and Union Carbide Corp. These companies produced various grades of graphite for use in battery and electric motor applications, crucibles, and other refractory products. Part of the synthetic graphite produced was in powder form for steelmaking applications; and for use as an additive in nonferrous metallurgy, foundry fittings, and in lubricants.

Gypsum.—New York was one of 22 States with gypsum production during 1977. United States Gypsum Co. in Genesee County was the only producer in the State; production increased over that reported for 1976. Gypsum was calcined in six plants and used in the manufacture of wallboard and lath, pottery, glass, industrial molding, and art.

Lime.—Allied Chemical Corp. in Syracuse and Bethlehem Steel Corp. in Lackawanna produced quicklime used in alkalies and in the basic oxygen furnace steel process. Production and value increased over that reported for the previous year.

Nitrogen Compounds.—Two companies with plants in the Niagara Falls area recovered atmospheric nitrogen for use in anhydrous ammonia preparation. The ammonia is used in the chemical and fertilizer industries.

Perlite.—Four companies, Buffalo Perlite Co., National Gypsum Co., United States Gypsum, and Georgia-Pacific Corp., expanded perlite shipped from western mines for a variety of uses. Approximately half of the production was used in horticulture and agriculture applications; with the remainder sold for filter aids, construction aggregate, insulation board, and other insulation applications. Production was reported at 6,155 tons valued at $838,000, with an average value per ton of $136.00.

Salt.—Rock salt was produced from mines in Livingston and Tompkins Counties. Evaporated salt was produced at two operations in Schuyler County and from one operation in Wyoming County.

The principal use of rock salt is in highway ice control. The chemical and food industries use significant tonnages. Most evaporated salt was used for seasoning and food processing. Production of evaporated and rock salt was reported at 6.5 million tons valued at $73 million.

Table 4.—New York: Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1973	5,202	42,364
1974	6,464	57,705
1975	5,978	57,344
1976	6,495	66,441
1977	6,452	72,623

Sand and Gravel.—New York sand and gravel production during 1977 was reported at 29 million tons valued at $58 million. The average value per ton was calculated at $1.97. Concrete aggregate, roadbase and coverings, and fill were the three major use categories. Four hundred and seventy-one mines were in operation; over half reported production of less than 25,000 tons.

Stone.—The State's stone industry produced limestone, basalt, sandstone, and slate. Total production of all stone was reported at 30 million tons valued at $91 million. Stone ranked second in value of minerals produced in New York.

Crushed stone was produced by 52 companies from 86 quarries for building aggregate, roadbase aggregate, cement, and other uses. Output increased 6% to 29.9 million tons valued at $88.5 million. Koppers Co., Allied Chemical Corp., and Lone Star Industries, Inc., were the leading producers.

Nineteen companies quarried dimension stone at 21 sites for rough flagging, cut building stone, and other uses. Output decreased 9% to 25,000 tons valued at $2.3 million. Leading producers were Johnston and Rhodes Bluestone Co., Cold Springs Granite Co., and Willis Hankins Bluestone Co.

Table 5.—New York: Construction and industrial sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	13,467	$26,493	$1.97
Gravel	15,596	30,311	1.94
Total	29,063	56,804	1.95
Industrial:			
Sand and gravel	134	766	5.72
Grand total	29,197	57,570	1.97

Table 6.—New York: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	9,032	$23,473	$2.60
Concrete products (cement blocks, bricks, pipe, etc.)	1,045	2,422	2.32
Asphaltic concrete aggregates and other bituminous mixtures	4,934	9,836	1.99
Roadbase and coverings	7,896	14,001	1.77
Fill	5,557	5,988	1.08
Other uses	599	1,085	1.81
Total	29,063	[1]56,804	1.95

[1] Data do not add to total shown because of independent rounding.

Table 7.—New York: Crushed stone[1], sold or used by producers by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Bituminous aggregate	5,966	17,380	6,299	18,630
Roadstone	4,986	12,930	4,838	12,740
Dense-graded roadbase stone	4,696	12,350	5,688	14,730
Cement manufacture	4,643	6,973	5,283	8,131
Concrete aggregate	2,884	7,779	3,214	18,781
Surface treatment aggregate	1,390	4,122	1,478	4,385
Riprap and jetty stone	983	3,102	608	1,975
Macadam aggregate	408	1,006	753	2,087
Fill	316	890	W	W
Agricultural limestone	258	1,358	334	1,752
Railroad ballast	256	602	318	844
Bedding material	20	33	16	36
Terrazzo and exposed aggregate	10	139	W	W
Other uses[2]	1,290	4,157	1,103	4,418
Total[3]	28,109	72,829	29,922	88,509

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, traprock, sandstone, slate, and granite.

[2] Includes stone used as chemical stone, other fillers, lightweight aggregate, asphalt filler, drain fields, whiting, lime manufacture (1976), abrasives, flux stone, other uses, and uses indicated by the symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 8.—New York: Dimension stone[1], sold or used by producers by use

Use	1976		1977	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Rough flagging	9,434	$825	7,733	$789
Cut stone	4,883	671	5,553	857
Dressed flagging	7,002	352	4,588	243
Rubble	2,207	38	3,445	41
Flooring slate	887	184	949	194
Irregular-shaped stone	889	22	902	32
House stone veneer	1,068	34	699	30
Other uses[2]	1,122	84	1,184	86
Total	27,492	[3]2,211	25,053	2,272

[1] Includes sandstone, granite, slate, and limestone.

[2] Includes stone used in rough blocks, structural and sanitary purposes, curbing, construction (1976), and other uses.

[3] Data do not add to total shown because of independent rounding.

Sulfur.—Sulfur, a byproduct of petroleum refining, was recovered by Ashland Oil & Refining Co. at its refinery at Buffalo in Erie County.

Talc.—Gouverneur Talc Co., Inc., operated three mines and three mills in St. Lawrence County to produce a ground product used principally in ceramics and paint. Production decreased from that reported in 1976.

Vermiculite.—The Construction Products Div. operation of W. R. Grace & Co. in Weedsport exfoliated vermiculite mined in the Western United States. Over half of the production was used for loose insulation, with block insulation and horticulture applications following in decreasing amounts.

Wollastonite.—Wollastonite, an ingredient in ceramic products and as a filler in paints and plastics, was produced at the Willsboro mine of Interpace Corp. in Essex County. This was the only wollastonite mine in the country; production decreased 8% while value increased 3.1%.

METALS

Aluminum.—Aluminum was produced by the Aluminum Co. of America and Reynolds Metals Co. near Massena in St. Lawrence County. Production and value increased over that reported for 1976. Reynolds Metals Co. intends to increase production capacity if an additional 100-megawatt power supply can be obtained. The Power Authority of the State of New York is expected to have additional Canadian power for sale in 1979, but applications for additional power have already exceeded the expected supply.

Iron Ore.—NL Industries, Inc., and Jones & Laughlin Steel Corp. produced iron ore from mines in Essex County and St. Lawrence County, respectively. The ore was beneficiated to a concentrate and shipped for use in pig iron manufacture, cement manufacture, for heavy media separation.

Lead.—Byproduct lead from zinc mining was produced from the Balmat and Edwards mine of St. Joe Minerals Corp. in St. Lawrence County. The lead concentrate was shipped to a company smelter in Missouri.

Silver.—Silver was recovered from lead concentrates produced at the Balmat and Edwards mines of St. Joe Minerals Corp. Recovery increased over that of 1976.

Titanium Concentrates (Ilmenite).—Ilmenite concentrate, a coproduct of magnetite, was mined at an open pit operation near Tahawus in Essex County. Principal uses for the concentrate were in the production of titanium dioxide pigments.

Zinc.—The Balmat and Edwards mines of St. Joe Minerals Corp. in St. Lawrence County, the largest zinc mining operation in the United States, placed New York third in the country in zinc production. Output and value decreased slightly from that reported for 1976.

Table 9.—New York: Mine production (recoverable) of silver, lead, and zinc

	1975	1976	1977
Mines producing: Lode	2	3	3
Material sold or treated: Zinc ore thousand short tons	1,247	1,239	1,195
Production:			
Quantity:			
Silver troy ounces	56,047	49,199	56,353
Lead short tons	3,027	3,196	2,778
Zinc do	76,612	73,671	70,839
Value:			
Silver thousands	$248	$214	$260
Lead do	$1,302	$1,476	$1,706
Zinc do	$59,757	$54,517	$48,737
Total do	[1]$61,306	$56,207	$50,703

[1] Data do not add to total shown because of independent rounding.

MINERAL FUELS

Natural Gas.—Production of natural gas in New York increased 16% over that reported in 1976, with production at the 10.6-billion-cubic-foot level. Current proven reserves are reported at 150 billion cubic feet. Exploration drilling was at an alltime high and was concentrated in the far western part of the State.

Peat.—Orange County led the State in peat production, with the majority of the shipments used for horticulture purposes.

Petroleum.—Crude oil production dropped 4% below that reported in 1976 to 824,000 barrels. Estimates of proven reserves total 9.1 million barrels, with an additional 3.3 million barrels of indicated reserves in known reservoirs. During the year, New York crude (Pennsylvania grade) sold for $14.20 per barrel.

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[1] State Liaison Officer, Bureau of Mines, New York, N.Y.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
The Carborundum Co	Box 423 Niagara Falls, NY 14302	Plant	Niagara.
Fanner Manufacturing Co	Brookside Park Cleveland, OH 44109	do	Erie.
General Abrasives Co., a division of U.S. Industries, Inc.	2100 College Ave. Niagara Falls, NY 14302	do	Niagara.
Pellets, Inc	531 South Niagara St. Tonawanda, NY 14150	do	Erie.
Aluminum smelters:			
Aluminum Co. of America	1210 Alcoa Bldg. Pittsburgh, PA 15222	do	St. Lawrence.
Reynolds Metals Co	Box 27003-2A Richmond, VA 23215	do	Do.
Cement:			
Alpha Portland Cement Co.[1]	15 South 3rd St. Easton, PA 18043	do	Greene.
The Flintkote Co.[2]	400 Westchester Ave. White Plains, NY 10604	do	Warren.
Lehigh Portland Cement Co.[2]	718 Hamilton St. Allentown, PA 18105	do	Greene.
Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, IL 60606	do	Do.
Newmont Mining Corp.[1,2]	Box 30 Stamford, CT 06904	do	Albany.
Clays:			
Lone Star Industries, Inc.[1]	One Greenwich Plaza Greenwich, CT 06830	Pits	Ulster.
Nassau Brick Co., Inc	635 Round Swamp Rd. Long Island, NY 11804	do	Nassau.
Norlite Corp	628 South Saratoga St. Cohoes, NY 12047	do	Albany.
Emery:			
De Luca Emery Mine, Inc	926 Constant Ave. Peekskill, NY 10566	Pit	Westchester.
Garnet:			
Barton Mines Corp	North Creek, NY 12853	Pit	Warren.
Gypsum:			
Georgia-Pacific Corp.[3]	Box 311 Portland, OR 97207	Plants	Erie and Westchester.
National Gypsum Co.[3]	325 Delaware Ave. Buffalo, NY 14202	Plant	Bronx.
United States Gypsum Co.[3]	101 South Wacker Dr. Chicago, IL 60606	Underground mine and plants.	Genesee, Richmond, Rockland.
Iron ore:			
Jones & Laughlin Steel Corp	Star Lake, NY 13690	Pit	St. Lawrence.
NL Industries, Inc.[4]	Tahawus, NY 12879	Pit	Essex.
Lime:			
Allied Chemical Corp.[1,5]	Box 70 Morristown, NJ 07960	Plant	Onondaga.
Bethlehem Steel Corp	701 East 3rd St. Bethlehem, PA 18016	do	Erie.
Peat:			
Anderson Peat Co., Inc	Pleasant Hill Rd. Wingdale, NY 12594	Bog	Dutchess.
Sterling Forest Peat Co., Inc	Box 608 Tuxedo, NY 10987	Bog	Orange.
Petroleum:			
Ashland Oil & Refining Co.[1]	Tonawanda, NY 14150	Refineries	Erie.
Mobil Oil Corp	Buffalo, NY 14221	do	Do.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Salt:			
Cargill, Inc	1620 Northstar Ctr. Minneapolis, MN 55402	Underground mine	Tompkins.
International Salt Co	Clarks Summit, PA 18411	do	Livingston.
Morton Salt Co	110 North Wacker Dr. Chicago, IL 60606	Well	Wyoming.
Watkins Salt Co., Inc	Box 150 Watkins Glen, NY 14891	do	Schuyler.
Sand and gravel:			
Albany Gravel Co	North Pearl St. & Loudonville Albany, NY 12201	Pit	Albany and Rensselaer.
Buffalo Slag Co	111 Great Arrow Ave. Buffalo, NY 14216	Plants	Allegany, Cattaraugus, Steuben.
Colonial Sand & Stone Co., Inc.[1] [2] [6]	1740 Broadway New York, NY 10019	Pit	Dutchess and Nassau.
General Crushed Stone Co	712 Drake Bldg. Easton, PA 18042	Pit	Cattaraugus and Chemung.
Keyway Mason Supply Corp	25 Montclair Ave. St. James, NY 11780	Pit	Suffolk.
Roanoke Marbro Sand & Gravel Corp	Box 172 Riverhead Long Island, NY 11901	Pit	Do.
Stone:			
The Callanan Road Improvement Co.	South Bethlehem, NY 12161	Quarry	Albany and Ulster.
Dolomite Products Co.[7]	1150 Penfield Rd. Rochester, NY 14625	do	Monroe.
General Crushed Stone Co	712 Drake Bldg. Easton, PA 18042	do	Genesee, Herkimer, Jefferson, Livingston, Onondaga, Ontario, Wayne.
Martin Marietta Corp	Box 120 Mercersberg, PA 17236	do	Rockland.
Talc:			
Gouverneur Talc Co., Inc	Gouverneur, NY 13642	Underground mine	St. Lawrence.
Wollastonite:			
Interpace Corp	Willsboro, NY 12996	do	Essex.
Zinc:			
St. Joe Minerals Corp.[8]	250 Park Ave. New York, NY 10017	Mine	St. Lawrence.

[1] Also stone.
[2] Also clays.
[3] Also expanded perlite.
[4] Also ilmenite.
[5] Also salt.
[6] Also cement.
[7] Also sand and gravel.
[8] Also silver and lead.

The Mineral Industry of North Carolina

This chapter has been prepared under a Memorandum Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Division of Earth Resources, North Carolina Department of Natural and Economic Resources, for the collection of information on all minerals except fuels.

By Lawrence E. Shirley[1] and Eldon P. Allen[2]

In 1977, the total value of mineral production in North Carolina reached an alltime high for the State. The total value was $231.5 million, an increase of 14% over the previous record high value of $203.3 millions established in 1976.

The State continued to lead the Nation in the production of feldspar, lithium minerals, scrap mica, and pyrophyllite. During 1977, North Carolina was again the only pyrophyllite-producing State in the Nation.

Stone was the leading mineral commodity produced, in terms of value, followed by phosphate rock, sand and gravel, cement, and lithium compounds. These five commodities accounted for 89% of the State's total mineral production value for 1977. North Carolina continued to lead the Nation in brick production from clay and shale. The State ranked second in output of crushed granite, third in output of crushed marble, and fourth in crushed marl and dimension slate output.

Leading mineral-producing companies in the State, in terms of the value of minerals produced, are listed here alphabetically: Ideal Basic Industries, Inc. (cement); Southeast Div. of Martin Marietta Corp. (crushed stone); Nello L. Teer Co. (crushed stone); Texasgulf, Inc. (phosphate rock); and Vulcan Materials Co. (crushed stone).

Legislation and Government Programs.—The Geological Survey Section of the North Carolina Division of Land Resources (formerly the Geology and Mineral Resources Section of the Division of Earth Resources) continued its geologic resources program during 1977. The Section gathered, evaluated, and distributed information on the topography, geology, and mineral and energy resources of the State. The responsibility of the Land Resources Division and the Survey Section is to promote the exploration, development, and wise conservation of the State's resources.

During the year, the Geological Survey Section completed several important mineral resource projects. Under an agreement with the Federal Bureau of Mines, the Section continued to collect mineral production statistics and also continued a cooperative clay-sampling and clay-testing program that examined the clays and shales from several counties in western North Carolina. A report and map of the geology and mineral resources of a 7,700-square-mile area in parts of the Piedmont and coastal plain areas of the State were completed. The Survey Section conducted this project with the cooperative support of the National Uranium Resources Evaluation Program, U.S. Department of Energy, and the report is on open file.

The Survey Section also completed a mapping program that used high-altitude aerial photography to produce orthophotoquads of central and western North Carolina; the program cost was shared equally with the Geological Survey, U.S. Department of the Interior. During the year, the first compre-

Table 1.—Mineral production in North Carolina[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Clays[2] thousand short tons	2,750	$4,677	3,022	$4,990
Feldspar short tons	515,477	11,549	509,976	11,410
Gem stones	NA	75	NA	75
Mica, scrap thousand short tons	70	3,793	91	4,207
Sand and gravel do	9,049	18,287	9,690	21,269
Stone:				
Crushed do	30,839	78,632	32,810	87,254
Dimension do	38	3,830	40	3,041
Talc and pyrophyllite short tons	113,754	1,087	W	W
Combined value of asbestos, cement, clays (kaolin), lithium minerals, mica (sheet), olivine, phosphate rock, and items indicated by symbol W	XX	r81,409	XX	99,265
Total	XX	r203,339	XX	231,511
Total 1967 constant dollars	XX	104,374	XX	p114,274

pPreliminary. r Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes kaolin; included with "Combined value" figure.

Table 2.—Value of mineral production in North Carolina, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Alamance	W	W	Stone, clays, talc.
Anson	W	$5,267	Sand and gravel, stone.
Ashe	W	W	Stone.
Avery	W	W	Clays, mica, sand and gravel, stone.
Beaufort	W	W	Phosphate rock, sand and gravel.
Bertie	$227	W	Sand and gravel.
Bladen	W	23	Do.
Brunswick	W	53	Do.
Buncombe	W	W	Stone, sand and gravel, clays.
Burke	W	W	Stone, sand and gravel.
Cabarrus	W	1,135	Stone, sand and gravel, clays.
Caldwell	W	W	Stone, sand and gravel.
Camden	W	--	
Caswell	W	W	Stone.
Catawba	W	W	Stone, sand and gravel.
Chatham	879	970	Clays, stone.
Cherokee	W	W	Stone, talc.
Chowan	1	W	Sand and gravel.
Cleveland	11,112	12,481	Lithium minerals, mica, feldspar, stone, sand and gravel, clays.
Craven	W	W	Stone, sand and gravel.
Cumberland	878	696	Sand and gravel.
Currituck	W	10	Do.
Davidson	W	W	Stone, clays, sand and gravel.
Davie	W	W	Stone, sand and gravel.
Duplin	W	W	Do.
Durham	W	W	Stone, clays.
Edgecombe	W	W	Stone, sand and gravel.
Forsyth	W	W	Do.
Franklin	151	131	Sand and gravel.
Gaston	11,860	12,438	Lithium minerals, feldspar, stone, sand and gravel, mica.
Granville	W	W	Talc.
Greene	W	W	Sand and gravel.
Guilford	5,788	5,399	Stone, sand and gravel, clays.
Halifax	W	W	Clays.
Harnett	W	W	Sand and gravel, clays.
Haywood	W	W	Stone.
Henderson	W	W	Stone, clays.
Hertford	W	W	Sand and gravel.
Hyde	1	W	Do.
Iredell	W	W	Stone, sand and gravel, clays.
Jackson	W	W	Stone, mica.
Johnston	W	W	Stone, sand and gravel.
Jones	W	75	Stone.
Lee	W	W	Stone, clays, sand and gravel.
Lenoir	W	W	Sand and gravel.
McDowell	615	582	Do.
Macon	W	W	Stone, sand and gravel.
Martin	16	W	Sand and gravel.
Mecklenburg	W	W	Stone.

See footnotes at end of table.

Table 2.—Value of mineral production in North Carolina, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Mitchell	$10,327	$9,661	Feldspar, stone, mica, clays, sand and gravel.
Montgomery	1,010	W	Sand and gravel, stone, clays.
Moore	W	W	Talc, sand and gravel, clays.
New Hanover	17,939	23,476	Cement, stone, clays, sand and gravel.
Northampton	W	W	Sand and gravel.
Onslow	W	W	Stone, sand and gravel.
Orange	1,161	1,581	Stone, talc, mica, sand and gravel.
Pasquotank	W	W	Sand and gravel.
Pender	--	W	Do.
Pitt	W	W	Stone, sand and gravel.
Polk	W	87	Stone.
Randolph	W	W	Do.
Richmond	2,824	2,353	Stone, sand and gravel.
Robeson	16	--	
Rockingham	W	W	Stone, clays, sand and gravel.
Rowan	W	W	Do.
Rutherford	W	664	Stone.
Sampson	W	299	Clays, sand and gravel.
Scotland	W	6	Sand and gravel.
Stanly	490	754	Clays, stone.
Stokes	W	W	Stone, sand and gravel, clays.
Surry	W	3,797	Stone, sand and gravel.
Swain	W	W	Stone.
Transylvania	W	W	Stone, sand and gravel.
Tyrrell	--	W	Sand and gravel.
Union	W	W	Stone, clays.
Vance	W	W	Stone.
Wake	4,423	W	Stone, sand and gravel, clays.
Washington	16	W	Sand and gravel.
Watauga	486	641	Stone.
Wayne	253	187	Sand and gravel.
Wilkes	W	W	Stone, sand and gravel.
Wilson	W	W	Do.
Yadkin	W	W	Sand and gravel.
Yancey	2,111	W	Olivine, mica, sand and gravel, asbestos.
Undistributed[2]	130,750	148,744	
Total[3]	^{r}203,339	231,511	

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^{r}Revised W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Alexander, Alleghany, Carteret, Clay, Columbus, Dare, Gates, Graham, Hoke, Lincoln, Madison, Nash, Pamlico, Perquimans, Person, and Warren.

[2] Includes gem stones and sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of North Carolina business activity

		1976	1977^{p}	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,254.0	2,620.0	+16.2
Unemployment	do	159.0	155.0	-2.5
Employment (nonagricultural):				
Mining	do	4.6	4.8	+4.3
Manufacturing	do	756.0	779.3	+3.1
Contract construction	do	105.3	103.1	-2.1
Transportation and public utilities	do	99.1	103.2	+4.1
Wholesale and retail trade	do	402.8	413.4	+2.6
Finance, insurance, real estate	do	82.6	83.9	+1.6
Services	do	284.1	295.0	+3.8
Government	do	332.7	345.6	+3.9
Total nonagricultural employment	do	2,057.2	2,128.3	+3.5
Personal income:				
Total	millions	$29,920	$32,791	+9.6
Per capita		$5,478	$5,935	+8.3
Construction activity:				
Number of private and public residential units authorized		26,030	33,004	+26.8
Value of nonresidential construction	millions	$312.7	$392.9	+25.6
Value of State road contract awards	do	$171.8	$250.0	+45.5
Shipments of portland and masonry cement to and within the State	thousand short tons	1,679	1,787	+4.0

See footnotes at end of table.

Table 3.—Indicators of North Carolina business activity —Continued

	1976	1977ᵖ	Change, percent
Mineral production value:			
Total crude mineral value ... millions	$203.3	$231.5	+13.8
Value per capita, resident population	$37	$42	+13.5
Value per square mile	$3,867	$4,403	+13.9

ᵖPreliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

hensive publication to provide information on oil exploration in the State was published.[3]

A report on oyster shell resources was completed and published that indicated a significant shell resource in quantity and value in the eastern region of the Albermarle Sound. An addition to the geologic map series was also completed.

Minerals research in the State has been carried out by the Minerals Research Laboratory of the North Carolina State University at Asheville since 1946. Responsibilities of the laboratory include helping the North Carolina mining industry solve its technical problems, especially in mineral dressing; developing the State's mineral resources; and helping to establish new mineral industries in the State. During 1977, the laboratory began several projects that were important to the mineral industry of North Carolina. The projects included flotation of coarse feldspar and other feldspar research, disposal of clay slimes, recovery of heavy minerals from sand plant wastes, recovery of pyrophyllite and andalusite from ore and wastes, beneficiation of olivine by flotation and gravity methods, gravity concentration of chromite ore, and numerous other projects.

North Carolina's lack of fuels became an issue of great concern to the State Government during the year. At present, no fuels are being produced in the State; and all natural gas, coal, gasoline, oil, and other fuels must be brought in from out-of-State sources.

As a result of this fuel deficiency, several companies have curtailed plant production or shifted to other fuels. A large fertilizer-manufacturing operation announced in November that it would shut down operations for 5 months because it could not get enough natural gas to stay in business. Another industry that suffered from the gas curtailment was the brick manufacturing industry; several brickmaking operations closed temporarily or were forced to switch to alternate fuels.

The task force group of the Governor's Energy Policy Council completed a study and report that indicated that North Carolina, because of dwindling natural gas supplies and the rising cost of coal, was fast becoming an all-electric society. The Governor established the North Carolina Energy Policy Council during the natural gas shortage of the winter of 1976-77 to assess the energy situation in the State and to carry out long-range and emergency planning. The Council stated that by 1990 the State will depend on electricity for over half of its energy needs. Almost two-thirds of the electricity is expected to come from nuclear plants, according to the Council report. The Council offered 14 recommendations for providing more rational management of energy resources. The top-priority recommendation of the Council called for energy conservation.

In 1977, North Carolina became the first State in the Southeast to have its energy conservation plan accepted, and received a $520,000 grant under the Federal Energy and Conservation Act of 1975 to start its conservation program. Similar plans have been approved in only two other States in the Nation. State officials expect to receive $4.5 million for the program during the next 3 years. North Carolina's projected energy consumption for 1980 is 1,736 trillion British thermal units (Btu's). The

State's goal is to reduce energy consumption by 5.7% for 1980, which would save about 1,736 Btu's for the year.

North Carolina also received a $274,000 grant from the Federal Energy Administration during the year to begin a 5-year energy conservation program. The grant will pay for the first year of the program, including the study of electric power-load management, such as peak-load pricing; development of cost-based natural gas rates that would encourage conservation; and other pilot projects. Electric power and natural gas utilities will ultimately be responsible for continuing the program.

North Carolina developed a draft of the North Carolina Coastal Zone Management Plan during 1977 in response to the Federal Coastal Zone Management Act of 1972. The plan was written by the North Carolina Department of Natural Resources, which was designated by the Governor as the lead agency for coastal zone management in the State. The purpose of the document was to define North Carolina's coastal zone and describe in detail the State's plan and policies for coordinated management of activities within the coastal zone that may directly and significantly affect coastal water. The draft plan was reviewed by the Federal Bureau of Mines and other Department of the Interior agencies to insure that Interior concerns were adequately expressed in the report.

A report on environmental and land-use permits for coastal areas was prepared by the Coastal Resources Commission and sent to the North Carolina General Assembly. The report contained recommendations for developing a better coordinated and more unified system of environmental and land-use permits in the coastal area in compliance with a section of the Federal Coastal Area Management Act.

In 1977, the Forest Service of the U.S. Department of Agriculture began to identify roadless and undeveloped areas in the national forests of North Carolina. The inventory that resulted designated 207,000 acres in 24 areas of the State for possible inclusion in the Roadless Area Review and Evaluation Program. Nineteen of the areas were in the Pisgah and Nantahala National Forests in western North Carolina, one was in the Uwharrie National Forest in central North Carolina, and four were in the Croatan National Forest near the coast. After additional study and public hearings on proposed areas, final recommendations are to be passed along to Congress, possibly in early 1979, for further debate, study, and final action.

Trends and Developments.—The State effected several changes during the year that concerned industrial development in North Carolina and were intended to increase performance and better coordinate industrial activities. The 1977 session of the North Carolina General Assembly transferred the State's economic and development functions from the Department of Natural and Economic Resources to the State's Department of Commerce. Within the Department of Commerce, these functions were organized into four separate divisions. The newly formed divisions are Industrial Development, International Development, Business Assistance, and Travel and Tourism. In industrial development, total investments in new and expanding industries reached new highs during the year. Industrial investments in 1977 exceeded $1.4 billion and resulted in nearly 27,000 new jobs.

North Carolina, like many other southeastern States, has been successful in attracting an increasing number of foreign business and manufacturing investments. Sixteen nations are now involved in a variety of North Carolina business activities. More than 127 of the foreign operations are engaged in manufacturing; others are primarily involved in sales and services activities. The Federal Republic of Germany, the United Kingdom, and Canada are the leading foreign investors in the State. During the past 10 years, over $250 million in investments has been added to the State's economy by foreign firms, resulting in more than 8,500 new industrial jobs.

An issue of growing significance in the State is water use and its effects on water supply. Ground water supplies are the subject of increasing attention throughout the State, especially in many of the eastern counties. Severe drops in ground water levels, although detected only in isolated cases, prompted an important study to try to determine the long-range impact of continued industrial and municipal use of ground water in a seven-county area. The 2-year, $128,000 study, will be financed by the Coastal Plains Regional Commission and conducted by the State Division of Environmental Management. This study will also provide information about the factors that affect water conditions in the area, and it is expected that this information can be used to assure that the ground water resource is properly managed.

In 1977, the North Carolina Department of Natural Resources and Community Development published a water resources framework study to inform the people of the State about water supply, recreation, and conservation; but the study was also considered by many as a step toward a State water plan. Several proposed water projects throughout the State were discussed in this study, and the discussions reflected the positions of State water planners on what projects the State should undertake.

New exploration began in the State that could lead to future production of fuels and less dependency on outside sources for fuel.

North Carolina has more than 1 million acres of land that has peat below the surface. At least one company, First Colony Farms, Inc., near Cresswell, has undertaken studies on its 372,000-acre farm in Washington, Tyrrell, Hyde, and Dare Counties, that could lead to the production of peat as a fuel. First Colony has calculated reserves of 407 million tons of peat, on 150,000 acres of its farm, and has estimated that there is enough peat on this farm alone to fuel a 400-megawatt electric generating plant for more than 150 years. The company has purchased peat mining equipment from the U.S.S.R. and Finland, and experimental peat mining is underway. North Carolina peat is reportedly very low in sulfur and ash, which makes it a much cleaner burning fuel than coal. If commercial mining of peat in North Carolina is proven feasible, the first domestic production of peat as a fuel would be possible.

In 1977, the French-American Metals Corp. (FRAMCO) completed its first phase of uranium exploration along North Harper Creek in Avery County. FRAMCO has a drilling permit from the U.S. Forest Service for 17,000 acres in Avery, Burke, and Caldwell Counties. Under provisions of the permit, the company must decide within 2 years whether it wants to mine the areas now being explored. FRAMCO originally based its interest in North Carolina on a report by the Energy Research and Development Administration that indicated possible uranium reserves in the area. The company has conducted a sampling and drilling program in the area, but no decision has been made on whether or not to proceed with the second phase of the program.

Demand for electric power continued to increase throughout the State, and the principal suppliers were attempting to enlarge their facilities to cope with the increased demand. The State's principal suppliers of electricity were Carolina Power & Light Co. (CP&L), Duke Power Co., and Virginia Electric & Power Co. (VEPCO). CP&L, at the end of 1977, was providing electric service to nearly 690,000 customers over an area of 30,000 square miles, including almost half of North Carolina and one-fourth of South Carolina. CP&L customers used 27.3 billion kilowatt-hours of electricity during the year. This electricity was generated from coal (60.9%), nuclear power plants, (34.6%), hydroelectric plants (2.6%), and No. 2 fuel oil (1.9%). In March 1977, the second unit of CP&L's Brunswick nuclear plant went onstream with an output of 790 megawatts. Total investment in the plant by the end of 1977 was approximately $726 million. CP&L spent $21.2 million in 1977 for construction of facilities to protect the environment. Of this amount, $12.1 million was spent for air quality control equipment, and $9.1 million was spent for water quality control devices. CP&L announced that it plans to build and operate a 1-million-ton-per-year underground coal mine in eastern Kentucky as a joint project with Pickands Mather & Co. Plans are for CP&L to own 80% of the property of the McInnes mine, and for Pickands Mather to own the remaining 20%. Pickands Mather would develop and manage the mine, under the plan. Production is slated to begin in about 2 years.

Duke Power Co.'s electric sales during 1977 totaled 48.8 billion kilowatt-hours, an increase of 7% over sales for 1976. Of the total kilowatt-hours generated in 1977, 71% came from coal-fired units, 25% from nuclear units, and the remaining 4% came from hydroelectric and other sources. Approximately 75% of Duke's coal requirements for existing plants, through the year 2000, will be met through long-term contracts with various coal suppliers. The balance will be provided by the company's own mining operations and by open-market purchases, according to company plans. New plant construction and nuclear fuel costs in 1977 totaled $644.6 million. During the year, Duke received a construction permit from the Nuclear Regulatory Commission (NRC) for the Cherokee nuclear station in South Carolina, and a license from the Federal Energy Regulatory Commission for the Bad Creek hydroelectric station, a 1-million-kilowatt pumped-storage facility that is planned to be built on an as-needed basis to help meet peak electrical loads on the Duke system.

VEPCO, with operations primarily in northeastern North Carolina and Virginia, sold 35.5 billion kilowatt-hours of electricity during the year. No breakdown was provided, however, for the area in North Carolina that is served by VEPCO. Of the company's total electric power generated during the year, 26% came from nuclear sources, 30% from coal, 43% from oil, and 1% from hydroelectric plants. The total cost of fuel for electric generation during the year amounted to $575 million.

Construction continued at the North Anna Nuclear Station in Louisa County. North Anna Unit 1 was completed; all preoperational testing was performed; and the unit was certified for fuels loading by NRC in early November 1977. Construction of the pumped-storage station in Bath County, was well underway at the end of the year. When completed, the station will have six units with a total generating capacity of 2,100 megawatts. Total cost of the station is estimated at $751 million.

The North Carolina State Port Authority operated the State's two main ports at Wilmington and Morehead City. Total 1977 tonnage of materials handled at the Wilmington port, including imports and exports, was 1.7 million tons, an increase of more than 4% over the tonnage handled in 1976. Total tonnage handled at the Morehead City port was 1.7 million tons, an increase of 17% over total 1976 tonnage. A total of 1,426 ships and barges called at the 2 ports, and deliveries of materials both to and from the ports were handled by 89,000 trucks and more than 8,000 railcars.

Imports of mineral products received by the Wilmington port included aluminum, copper, fertilizer, iron and steel, marble, slate, stone, chrome ore, salt, and titanium oxide. Exports included aluminum, bricks, cement clay, feldspar, lithium carbonate and lithium products, scrap iron and steel, and structural steel.

At the Morehead City port, 72% of the total export tonnage was either phosphate or phosphoric acid. Other exported mineral products included brick, fertilizers, and steel. Imports included asphalt, bunker C oil, and lead bars.

Employment and Injuries.—According to the Annual Report for 1977 on Administration of the Federal Metal and Nonmetallic Mine Safety Act (Public Law 89-577), North Carolina had 512 mining and milling operations that were active throughout the year. Mining Enforcement and Safety Administration (MESA) inspectors conducted 167 regular and 84 spot inspections of mines and mills during the year. Preliminary data indicated there were two fatalities in the State during the year. There were 51 disabling injuries reported by surface mines and 63 disabling injuries reported by mills. The frequency rate for disabling injuries for surface mines was 7.98 and for mills the rate was 18.98.

During 1977, a State Plan Agreement was in effect between MESA and North Carolina. Under this agreement, the State was given authority to issue notices of violations and withdrawal orders, or otherwise enforce health and safety standards. The State was required under the agreement to inspect all surface operations at least once a year. However, the Federal Mine Safety and Health Act of 1977 (Public Law 91-173, as amended by P.L. 95-164), which becomes effective March 9, 1978, does not provide for State plans. Therefore, all State plans will no longer be in effect on that date. MESA is to be superseded by the Mining Safety and Health Administration (MSHA), and MSHA inspectors will perform the inspections required by the new law in States where State plans are now in effect. MESA continued to maintain a field office throughout the year at Salisbury.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Powhatan Mining Co. produced a small amount of asbestos from its Hippy mine in Yancey County.

Cement.—Ideal Basic Industries, Inc., the only cement-producing company in the State, produced both masonry and portland cement at its plant near Castle Hyne in New Hanover County. Output and value increased for both cements, compared with output and value for 1976. Ideal also operates a cement-handling terminal at Wilmington and has a sales office in Raleigh.

Clays.—Clay and shale production continued at a high level during 1977. Clay and shale produced for the manufacture of heavy clay products and cement totaled 3.1 million tons valued at over $5.0 million, an increase of 10% in output and 7% in value over the previous year's output and value. Kaolin production and value also showed substantial increases. Twenty-five companies with 45 mines produced common clay and shale and kaolin. Leading producers during 1977, listed in descending order of output, were Sanford Brick Corp. (3 mines), Pine Hall Brick & Pipe Co. (4 mines), Solite Corp. (2 mines), and Boren Clay Products Co. (4 mines). These four companies, with 13 mines out of the State's 46-mine total, were responsible for 42% of the output and 31% of the value of the total common clay and shale production.

Kaolin was produced by only two companies, Harris Mining Co. in Avery County and Kings Mountain Silica Co. in Cleveland County. This kaolin was both processed and unprocessed, and was used principally in the manufacture of specialty china and refractories and for face brick.

North Carolina continued to lead the Nation in brick production, a distinction held by the State since 1962. The brick industry continued to make improvements in automation and other technological advancements that contributed to increased production. The Brick Association of North Carolina, with headquarters in Greensboro, continued as the organizational representative for most of the brick producers in the State. According to the Brick Association, total output during 1977 was 1.1 billion brick valued at $106.2 million, an increase of 14% in output and 36% in value over output and value for the previous year.

Table 4.—North Carolina: Common clay and shale sold or used by producers, by county

County	1976			1977		
	Number of mines	Quantity (short tons)	Value	Number of mines	Quantity (short tons)	Value
Alamance	1	W	W	2	77,467	$131,694
Buncombe	1	36,000	$52,200	1	W	61,200
Cabarrus and Durham	4	265,775	415,213	4	245,439	499,502
Chatham	4	442,277	879,489	4	479,548	939,849
Davidson	1	80,000	104,000	1	90,000	126,000
Guilford	3	71,331	103,500	2	74,482	193,731
Harnett	2	35,200	53,478	1	W	W
Henderson	1	54,000	78,300	1	W	91,800
Iredell	1	23,398	33,900	1	W	W
Lee	4	414,895	662,720	3	514,000	395,600
Montgomery and New Hanover	4	139,544	300,454	4	173,493	383,711
Rockingham	5	375,505	491,000	5	438,304	455,042
Rowan	4	162,722	232,800	4	166,285	280,375
Sampson	1	58,642	85,000	1	56,125	189,141
Stanly	3	279,370	489,900	3	302,700	704,350
Stokes	1	25,418	28,000	1	21,207	16,966
Union	1	165,926	497,800	1	173,585	303,774
Undistributed[1]	4	120,008	169,500	4	209,420	216,850
Total	45	2,750,011	4,677,254	43	3,022,055	4,989,585

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1] Includes Halifax, Moore, and Wake Counties and data indicated by symbol W.

Feldspar.—North Carolina led the Nation in the production of feldspar for 1977, and the State's Spruce Pine District continued to be the principal feldspar-producing area in the Nation. The mining of feldspar began in 1911 and has been continuous since that time. Production and value during 1977 were slightly less than in the previous year, but both continued at a high level. Total output was 510,000 tons valued at $11.4 million, compared with 515,000 tons valued at $11.5 million for 1976.

Six companies operated eight mines in Cleveland, Gaston, and Mitchell Counties. Two of the companies in Mitchell County operated two mines each and the other four companies operated one mine each.

Leading feldspar-producing companies, listed in descending order of output, were The Feldspar Corp.; IMC Chemical Group, Inc.; and Lawson-United Feldspar and Mineral Co., now a part of Indusmin, Ltd. All three companies are in Mitchell County. Other feldspar-producing companies were Lithium Corp. of America in Gaston County, Foote Mineral Co. in Cleveland County (both are also producers of lithium compounds in the State), and Kings Mountain Mica Co., Inc., in Cleveland County. Most of the feldspar produced was in the form of flotation concentrates or feldspar-silica mixtures.

Late in 1977, Lawson-United was acquired by Indusmin, Ltd., a Canadian producer of nepheline syenite. Indusmin will continue to operate its new acquisition under the name Lawson-United Feldspar and Mineral Co.

Gem Stones.—Amateur collectors and rockhounds collected a variety of precious and semiprecious gems and mineral specimens from several areas of the State. Most of the collecting activity was centered around Franklin in Macon County, Spruce Pine in Mitchell County, and near Hiddenite in Alexander County. Garnet, rubies, and sapphires were found in the Franklin area; emeralds and aquamarine gems were found in the Spruce Pine area; and hiddenite and emeralds were found in the Hiddenite area. Many of the lesser gems and minerals were also found in these areas.

In 1977, a 456-carat ruby was found at the Gregory ruby mine on Cowee Creek near Franklin in Macon County. There were several active panning operations in the same area and several lesser rubies were also found. The Big Crabtree emerald mine near Spruce Pine was also active during the year.

The Museum of North Carolina Minerals, operated by the National Park Service (NPS), U.S. Department of the Interior, is located near Gillespie Gap at milepost 331 on the Blue Ridge Parkway. This museum introduces visitors to the varied mineral resources of western North Carolina and houses some excellent collections of rocks and minerals from other areas of the State as well. The museum is the result of a joint State and Federal effort and the efforts of the citizens of the Spruce Pine area. These citizens established the museum, and it was their efforts that provided choice mineral specimens and an attractive building for exhibits. In 1955, the museum was turned over to NPS, which then assumed responsibility for its operation and maintenance. Inquiries regarding the museum and its activities should be addressed to: The Superintendent, Blue Ridge Parkway, 703 Northwestern Bank Bldg., Asheville, N.C. 28801.

Graphite.—Synthetic graphite products, including anodes, electrodes, crucibles and vessels, and graphite specialties, were produced by Great Lakes Carbon Corp. at its plant near Morganton. The plant uses coal tar pitch obtained from out-of-State sources as raw material.

Gypsum.—Texasgulf marketed byproduct gypsum recovered from the manufacture of phosphoric acid at its fertilizer processing operation at Lee Creek near Aurora. Principal uses for the material were as a soil additive and for landfill.

Iodine.—Mallinckrodt Chemical Works, near Raleigh in Wake County, consumed crude iodine in the manufacture of several products. The company operated three plants in the Raleigh area and produced high-purity speciality chemicals, plastics, and other products.

Lithium Minerals.—North Carolina led the Nation in the production of lithium minerals in 1977. Two companies operated lithium mining and processing facilities in the State; Foote Mineral Co. operated a mine and plant near Kings Mountain in Cleveland County, and Lithium Corp. of America (Lithcoa) operated mines and a plant near Bessemer City in Gaston County. Both companies produced spodumene from pegmatites in the area. Total output during 1977 increased 19% over the total output for 1976, but value remained about the same.

According to Gulf Resources & Chemical Corp.'s annual report for 1977, its subsidiary, Lithcoa, produced lithium at record levels during the year, and set record highs in sales and earnings as well. As a result of increasing demand for lithium products, an expansion program was initiated at Lithcoa's chemical plant. The expansion program was designed to increase the plant's productive capacity by approximately 60%, from 27 million pounds of lithium carbonate equivalent to 44 million pounds over the next several years.

The initial stages of the expansion program are planned to increase plant capacity to 36 million pounds and plans are to include equipment designed to accommodate further expansion to 44 million pounds at a relatively modest cost per unit of production. The expansion program is scheduled for completion in 1981. Mining and milling operations are also scheduled for additional expansions to coincide with the chemical plant expansion. Another Lithcoa development during the year was the commercial production of scrap mica. A new mica-recovery circuit was put into operation in the Lithcoa mill and is now recovering marketable mica that was formerly wasted. Lithcoa continued to emphasize market development, cost reduction, and expansion. Research and market-development activities focused on battery technology and on new products for the pharmaceutical and polymer industries.

According to Foote's 1977 annual report, the company's 12-million-pound-per-year lithium carbonate plant did not reach its designed capacity until late in the year. Significant startup problems were experienced early in the year, but were gradually resolved. Sales of Forte's lithium products reached an alltime high due to increased use of lithium carbonate by the aluminum industry and modest price increases. Interest in lithium for battery applications remained high.

Mica.—North Carolina also led the Nation in the production of scrap mica. Total production was 91,379 short tons valued at $4.2 million, an increase of 30% in output and 11% in value over output

Table 5.—North Carolina: Ground mica sold or used by producers, by use

Use	1976		1977	
	Quantity (short tons)	Value	Quantity (short tons)	Value
Roofing	3,270	$146,436	3,216	$199,950
Paint	7,199	1,542,331	7,929	1,632,553
Rubber	4,680	1,010,300	5,121	1,197,323
Joint cement	22,860	1,997,511	25,460	2,423,918
Other uses[1]	31,491	2,463,641	42,663	3,320,319
Total	69,500	7,160,219	84,389	8,774,063

[1] Includes brick, plastics, textile coating, wallpaper, well drilling, and unspecified uses.

and value for 1976. Ten companies produced scrap mica from 12 mines in 7 counties. Principal producing companies, listed in descending order of output, were Harris Mining Co., Avery County; Kings Mountain Mica Co. Inc., Cleveland County; Piedmont Minerals Co., Inc., Orange County; Deneen Mica Co., Inc., Yancey County; and The Feldspar Corp., Mitchell County. These five companies were responsible for 75% of the total scrap mica produced during 1977.

Olivine.—North Carolina also led the Nation in olivine production. Total output and value were nearly double the 1976 totals, denoting increased consumption of olivine as a blast-furnace additive and for the manufacture of refractories. Olivine took on added signifigance as an industrial mineral in North Carolina during 1977. In addition to the uses already mentioned, olivine is getting much attention because of its value as a heat-storage material. The State's Minerals Research Laboratory began looking into olivine for use as a heat-storage material that could trim home heating bills and reduce the need for expensive plants to generate electricity. It is envisioned that olivine could be processed into blocks or brick that would be put inside radiators. At night, when electricity costs less, heat could be stored in the blocks or brick; during the day, a small fan would blow out the stored heat. North Carolina, with olivine reserves estimated at 1.2 billion tons, has ample material for many uses currently under examination.

Late in the year, International Minerals & Chemical Corp. announced it was opening an additional olivine raw-materials mine and plant at Addie, because of increased demand for olivine. The mine, with reserves estimated at more than 6 million tons of olivine ore, has a production capacity of 25,000 tons of product per month. The company also operates another olivine mine near Burnsville and one in the State of Washington.

Perlite.—Carolina Perlite Co., Inc., near Gold Hill in Rowan County, expanded perlite from out-of-State sources. The material was used primarily for construction aggregate, as horticultural and agricultural aggregate, and as construction aggregate. The company did not disclose its output or value data.

Phosphate Rock.—In 1977, Texasgulf, continued to be the only company producing phosphate rock in North Carolina. Total output increased 19% and value increased 21% over output and value for 1976, establishing a new record for production. Phosphate rock was the State's second most valuable mineral commodity.

According to Texasgulf's annual report for 1977, several new developments announced by the company during the year would help increase output of phosphate rock and also contribute to phosphate exports. The company's new dredge-dragline mining system at Lee Creek, near Aurora, became fully operational about midyear, and mining rates and recoveries at Lee Creek improved substantially during the last 6 months of the year.

Texasgulf also announced it would build additional storage and shipping facilities for its fertilizer materials at the Morehead City port. These new facilities, estimated to cost $10 million, are planned to include an ammonia terminal and at least two dry-fertilizer storage buildings. During the year, the Lee Creek operation increased production and sales of byproduct hydrofluosilicic acid, which is used for water treatment in major eastern cities. The company also marketed byproduct gypsum obtained from the manufacture of phosphoric acid (P_2O_5) for use as a soil conditioner and fill material.

The company's new mining system will permit expansion of concentrator and calciner capacity from 3.5 million to 5 million tons of phosphate rock per year. When market conditions improve, sufficient rock will be available to increase acid production from the present 680,000 tons of P_2O_5 per year to 1 million tons. Rock will also be available for increased dry fertilizer production and, in addition, provide for export sales of 500,000 tons per year.

According to the Annual Roport, at Lee Creek, Texasgulf owns or leases about 35,000 acres containing approximately 2.2 billion tons of phosphate sands that contain an average of about 13% P_2O_5. About 1.2 billion tons of these phosphate sands are proven recoverable reserves.

North Carolina Phosphate Corp.'s plan to establish a phosphate mining operation adjacent to Texasgulf facilities moved a step closer to reality in 1977. The planned $250 million open pit mine and processing plant of Kennecott Copper Corp. and Agrico Chemical Co. has received most of the required permits and the companies are expected to move ahead with their mining plans as soon as economic conditions improve.

In December 1977, the U.S. Army Corps of Engineers issued a permit to North Carolina Phosphate Corp. to dredge an access channel and inland turning basin, dispose of dredged material, construct a bulkhead in the turning basin, install a submerged pipeline, excavate two discharge canals, dispose of mining waste, and build rail spur to cross three creeks and the Pamlico River near Aurora in Beaufort County. The issuance of this permit should allow the company to proceed with its mining and development plans.

Sand and Gravel.—Sand and gravel ranks as one of the State's most important industrial minerals and is indispensable as an aggregate in the building and construction industries. Sand and gravel ranked third in value among all mineral commodities in the State. Production in 1977 totaled 9.7 million tons valued at $21.3 million, compared with 9.0 million tons valued at $18.3 million in 1976, or an increase of 7% in output and 16% in value.

Sand and gravel was produced by 104 companies at 136 operations in 61 counties. The North Carolina State Highway Commission was the State's largest noncommercial producer of construction sand and gravel with 10 operations in 6 counties.

Construction sand and gravel comprised the bulk of all sand and gravel produced. Output for construction purposes was 8.8 million tons valued at $17.3 million. The State's leading producing companies of construction sand and gravel were B. V. Hedrick Gravel and Sand Co. and lessees of B. V. Hedrick with six operations in Buncombe, Anson, McDowell, and Mitchell Counties; Becker Sand & Gravel Co. with operations in Harnett and Cumberland Counties; W. R. Bonsal Co., Anson County; Nello L. Teer Co., Harnett County; and Barrus Construction Co. with seven operations in Lenoir, Onslow, Wayne, Pitt, and other counties. Rea Construction Co. had the most sand and gravel operations in the State, reporting production from 12 pits in Gaston, Edgecombe, Rowan, Johnston, and Iredell Counties.

Industrial sand was produced at seven operations in six counties; output was 857,000 short tons valued at $4 million. The leading producing companies of industrial sand were W. R. Bonsal and Cumberland Gravel and Sand Co. in Cleveland County.

During 1977, there were 73 sand and gravel operations that produced less than 25,000 tons each, but together they accounted for 53.6% of the total production; 29 operations produced between 25,000 and 49,999 tons and were responsible for 21.3% of the total; 26 operations produced from 50,000 to 199,999 tons and accounted for 19% of the total; and 8 operations produced over 200,000 tons each and together they accounted for the remaining 6% of total production.

Most of the sand and gravel was transported by truck, with a small percentage transported by rail or other methods.

Stone.—Stone lead all mineral commodities produced in the State in terms of value for 1977. Total stone output was 32.8 million tons valued at $90.3 million, compared with 30.9 million tons valued at $82.5 million in 1976, an increase of 6% in output and 9% in value over that of the previous year.

North Carolina ranked second among the States in output of crushed granite, third in crushed marble, and fourth in production of crushed marl and dimension slate.

Crushed stone was produced by 36 companies at 88 quarries. Uses included roadbase aggregate, concrete aggregate, bituminous aggregate, and others. Crushed stone output totaled 32.8 million tons valued at $87.3 million; a tonnage increase of 6% over that of 1976. Leading producers were Southeastern Div. of Martin Marietta Corp., Vulcan

Table 6.—North Carolina: Sand and gravel sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Anson	2	W	W	2	1,776	5,203
Avery	2	W	68	1	168	336
Beaufort	3	W	W	2	64	160
Bertie	5	179	227	2	W	W
Bladen	1	W	W	1	15	23
Brunswick	2	47	14	2	W	53
Buncombe	4	489	1,206	3	W	W
Burke	2	W	W	2	W	W
Cabarrus	3	133	122	3	145	183
Caldwell	2	W	W	2	W	W
Camden	1	W	W	--	--	--
Catawba	6	113	163	6	127	221
Chowan	1	4	1	1	W	W
Cleveland	6	235	600	6	440	1,006
Craven	1	62	W	1	71	W
Cumberland	5	568	878	5	426	696
Currituck	1	W	W	1	W	10
Davidson	1	W	W	1	4	6
Davie	2	W	W	2	W	W
Duplin	2	W	W	2	21	31
Edgecombe	2	W	W	4	168	277
Forsyth	1	W	W	1	3	5
Franklin	1	78	151	1	72	131
Gaston	5	31	W	5	40	W
Greene	1	W	W	1	W	W
Guilford	3	238	414	2	W	294
Harnett	2	W	W	2	W	W
Hertford	2	W	W	2	W	W
Hyde	1	5	1	1	W	W
Iredell	1	10	W	2	W	W
Johnston	3	27	W	3	31	W
Jones	1	W	12	--	--	--
Lee	2	W	W	2	W	W
Lenoir	3	W	W	3	W	W
McDowell	4	255	615	4	250	582
Macon	1	67	W	1	W	W
Martin	1	54	16	1	W	W
Mitchell	2	W	W	1	W	W
Montgomery	4	167	336	4	334	592
Moore	3	221	307	1	W	W
New Hanover	2	W	57	2	W	265
Northampton	2	W	W	2	W	W
Onslow	1	W	W	1	W	W
Orange	2	W	W	2	W	W
Pasquotank	2	W	W	2	W	W
Pender	--	--	--	1	W	W
Pitt	4	126	172	3	67	148
Richmond	4	468	1,562	4	381	1,069
Robeson	1	W	16	--	--	--
Rockingham	4	77	171	3	84	128
Rowan	4	17	W	3	28	W
Sampson	3	W	W	3	74	110
Scotland	1	W	W	1	4	6
Stokes	1	18	31	1	29	55
Surry	3	W	W	3	45	68
Swain	1	W	W	--	--	--
Transylvania	1	14	20	1	W	20
Tyrrell	1	(1)	(1)	1	W	W
Wake	1	18	36	1	19	28
Washington	1	53	16	1	W	W
Wayne	12	174	253	9	119	187
Wilkes	2	W	W	1	25	38
Wilson	1	W	W	1	W	W
Yadkin	1	W	W	1	W	W
Yancey	2	W	W	2	110	165
Other counties[2]	--	5,099	10,819	1	4,550	12,096
Total[3]	152	9,049	18,287	136	9,690	21,269

W Withheld to avoid disclosing company proprietary data; included with "Other counties."

[1] Less than 1/2 unit.

[2] Includes some sand and gravel that cannot be assigned to specific counties and items indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 7.—North Carolina: Sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	5,326	$8,750	$1.64
Gravel	3,508	8,517	2.43
Total[1] or average	8,833	17,267	1.95
Industrial:			
Sand	328	1,171	3.57
Gravel	529	2,831	5.35
Total[1] or average	857	4,003	4.67
Grand total[1] or average	9,690	21,269	2.19

[1] Data may not add to totals shown because of independent rounding.

Table 8.—North Carolina: Construction sand and gravel sold or used, by major use category

	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	3,885	$8,368	$2.15
Concrete products (cement blocks, bricks, pipe, etc.)	245	581	2.37
Asphaltic concrete aggregates and other bituminous mixtures	1,945	3,747	1.93
Roadbase and coverings	1,610	3,138	1.95
Fill	850	981	1.15
Other uses	299	451	1.51
Total[1] or average	8,833	17,267	1.95

[1] Data may not add to totals shown because of independent rounding.

Table 9.—North Carolina: Crushed stone[1] sold or used by producers, by use

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	8,184	18,370	13,960	34,580
Concrete aggregate	5,824	15,510	6,316	18,160
Bituminous aggregate	5,335	14,400	4,421	12,520
Roadstone	7,292	18,880	3,850	10,730
Railroad ballast	1,599	4,050	2,360	5,389
Surface treatment aggregate	765	2,110	549	1,862
Riprap and jetty stone	272	831	232	819
Terrazzo and exposed aggregate	19	351	22	125
Mineral food	W	W	17	157
Other uses[2]	1,549	4,130	1,079	2,911
Total[3]	30,839	78,632	32,810	87,254

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes granite, limestone, traprock, marl, sandstone, marble, and miscellaneous stone.

[2] Includes stone used in cement manufacture, soil conditioning, glass manufacture, fill (1976 only), macadam aggregate, agricultural limestone, filter stone (1977), unspecified uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Materials Co., and Nello L. Teer Co.

Dimension stone was quarried by 8 companies at 17 quarries for use as curbing, rough monumental stone, rough blocks, and other uses. Total output in 1977 was 40,425 tons valued at over $3.0 million. Leading producers were North Carolina Granite Corp., Jacob's Creek Stone Co., Inc., and Granite Quarry Corp.

Nellow L. Teer Co.'s new crushed granite plant near Rocky Mount was described.[6]

The plant came onstream in 1975, replacing an older plant in the area that was phased out by zoning. The new plant is rated at 600 tons per hour of finished products, and in its first full year of operation, plant production totaled 1.1 million tons of crushed granite.

The new plant has incorporated several new environmental concepts. Waste water from dust-settling systems and aggregate-washing operations is flumed to a settling pond, which overflows clean water to the adjacent raw water reservoir. Make-up water is pumped from the nearby Tar River to the water reservoir. In addition to the Rocky Mount facility, the company's quarry division operates other rock quarries at Durham, Raleigh, Princeton, and Neverson, as well as a large sand and gravel operation at Erwin. The company also operates a lightweight aggregate plant near Charlotte using fly ash as the raw material.

Talc and Pyrophyllite.—North Carolina was again the only pyrophyllite-producing State in the Nation. Combined output of talc and pyrophyllite decreased below that of 1976, but value increased. Talc was produced by only one company, Hitchcock Corp., from mines near Murphy in Cherokee County.

Pyrophyllite was produced by four companies at seven mines in four counties. Producing companies, listed in descending order of output, were Piedmont Minerals Co. Inc. (1 mine) in Orange County; Standard Minerals Co., Inc., (2 mines) in Moore County; Glendon Pyrophyllite, Inc., (3 mines) in Alamance and Moore Counties; and Tredmont, Inc., (1 mine) in Granville County. Most of the pyrophyllite was ground and sold for a variety of uses.

Table 10.—North Carolina: Dimension stone[1] sold or used by producers, by use

Use	1976			1977		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	(short tons)	(cubic feet)		(short tons)	(cubic feet)	
Curbing	15,680	196	$1,078	14,890	186	$770
Rough monumental	2,020	25	95	5,388	65	281
Rough blocks	1,676	20	46	3,618	44	142
Cut stone	3,080	38	739	2,481	31	465
Rubble	1,110	14	16	2,078	30	31
Other uses[2]	14,040	139	1,855	11,970	142	1,352
Total	37,606	432	[3]3,830	40,425	498	3,041

[1] Includes granite, slate, marble, sandstone, and miscellaneous stone.

[2] Includes irregular-shaped stone, structural and sanitary fixtures, dressed construction, dressed monumental, dressed flagging, and rough flagging.

Vermiculite.—W. R. Grace & Co. exfoliated vermiculite at a plant near High Point in Guilford County. The exfoliated product was used in concrete aggregate, plaster aggregate, loose-fill insulation, block insulation, and for horticultural purposes. Carolina Wholesale Florists, Inc., previously the operator of a plant near Sanford, was reportedly out of business in 1977.

METALS

Aluminum.—Primary aluminum was produced by the Aluminum Company of America (ALCOA) at its smelting operation near Badin in Stanly County. Raw material used in the plant was imported alumina. Estimated output and value of metal production increased moderately over 1976 output and value. ALCOA also operated an electric power utility, Nantahala Power & Light Co., near Franklin in Macon County, and an aluminum fabricating facility near Laurinburg, Scotland County.

Tungsten.—There was no recorded production of tungsten in North Carolina in 1977. Ranchers Exploration & Development Corp. continued to keep its Tungsten Queen mine and mill near Townsville in Vance

County in a standby condition. The mine was closed in 1971.

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[1] State Liaison Officer, Bureau of Mines, Raleigh, N.C.

[2] Chief, Geology and Mineral Resources Section, Division of Earth Resources, North Carolina Department of Natural and Economic Resources, Raleigh, N.C.

[3] Coffey, J. C. Exploratory Oil Wells of North Carolina 1925-1976. N.C. Dept. of Nat. and Econ. Res., Div. of Earth Res., Geol. and Min. Res. Sec., Inf. Circ. 22, 1977, 52 pp.

[4] Sampair, J. L. Buried Oyster Shell Resource Evaluation of the Eastern Region of the Albermarle Sound. N.C. Dept. of Nat. and Econ. Res., Div. of Earth Res., Geol. and Min. Res. Sec., Bull. 85, 1976, 47 pp.

[5] Merschat, C. E. Geologic Map and Mineral Resources Summary of the Mars Hill Quadrangle, N.C. N.C. Dept. of Nat. and Econ. Res., Div. of Earth Res., Geol. and Min. Res. Sec., GM-191-SE and MRS-191-SE, 1977, 15 pp., 1 map.

[6] Pit & Quarry. Vol. 70, No. 2, August 1977, pp. 56-65.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum, smelter: Aluminum Company of America.	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Stanly.
Asbestos: Powhatan Mining Co	6721 Windsor Mill Rd. Baltimore, MD 21207	Open pit mine	Yancey.
Cement: Ideal Basic Industries, Inc.[1] [2]	420 Ideal Cement Bldg. Denver, CO 80202	Plant	New Hanover.
Clays:			
Boren Clay Products Co	Box 368 Pleasant Garden, NC 27313	Open pit mines and plant.	Chatham, Guilford, Sampson.
Pine Hall Brick & Pipe Co	Box 11044 Winston Salem, NC 27106	do	Rockingham and Stokes.
Sanford Brick Corp	Drawer 458 Sanford, NC 27330	do	Chatham, Lee, Stanly.
Solite Corp	Box 27211 Richmond, VA 23261	do	Rockingham and Stanly.
Feldspar:			
The Feldspar Corp.[1] [2] [3]	Box 220 Spruce Pine, NC 28777	Open pit mines and plants.	Mitchell.
IMC Chemical Group, Inc.[3]	IMC Plaza Libertyville, IL 60048	do	Do.
Lawson-United Feldspar and Mineral Co.[3]	Box 309 Spruce Pine, NC 28777	do	Do.
Lithium minerals:			
Foote Mineral Co.[1] [4]	Box 792 Kings Mountain, NC 28086	Open pit mine and plant.	Cleveland.
Lithium Corp. of America [4]	449 North Cox Rd. Gastonia, NC 28052	do	Gaston.
Mica:			
Harris Mining Co.[1] [2]	Box 628 Spruce Pine, NC 28777	Open pit mines	Avery and Mitchell.
Kings Mountain Mica Co., Inc.[4]	Box 709 Kings Mountain, NC 28086	do	Cleveland.
Piedmont Minerals Co., Inc.[5]	Box 566 Hillsborough, NC 27278	Open pit mine and plant.	Orange.
Olivine: International Minerals & Chemical Corp.	Box 672 Spruce Pine, NC 28777	Open pit mines	Avery and Yancey.
Perlite, expanded:			
Carolina Perlite Co., Inc	Box 741 Hillside, NJ 07205	Plant	Rowan.
Phosphate rock:			
Texasgulf, Inc	Box 48 Aurora, NC 27806	Open pit mine and plant.	Beaufort.
Sand and gravel:			
Barrus Construction Co	Box 399 Kingston, NC 28501	Pits	Various.
Becker Sand & Gravel Co	Box 848 Cheraw, SC 29520	do	Cumberland, Harnett, Moore.
W. R. Bonsal Co	Box 38 Lilesville, NC 28091	do	Anson.
B. V. Hedrick Gravel and Sand Co.[1]	Swannanoa, NC 28778	do	Buncombe.
Nello L. Teer Co.[1]	Box 1131 Durham, NC 27702	do	Harnett.
Stone:			
Arrarat Rock Products Co	223 Willow St. Mount Airy, NC 27030	Quarry	Surry.
Ashland Oil Co., Harrison Div	Box 386 Alcoa, TN 37701	Quarries	Cherokee, Jackson, Macon.
Martin Marietta Corp	Box 30013 Raleigh, NC 27612	do	Various.
Vulcan Materials Co., Mideast Div.	Box 7506, Reynolds Station Winston-Salem, NC 27109	do	Do.

See footnotes at end of table.

Table 11.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Talc and pyrophyllite:			
Glendon Pyrophyllite, Inc	Box 306 Carthage, NC 28327	Open pit mines and plant.	Alamance and Moore.
Hitchcock Corp	Box 459 Murphy, NC 28906	do	Cherokee.
Standard Minerals Co., Inc	Box 278 Robbins, NC 27325	Open pit mine and plant.	Moore.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plants	Guilford.

[1] Also stone.
[2] Also clays.
[3] Also mica.
[4] Also feldspar.
[5] Also pyrophyllite.

The Mineral Industry of North Dakota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the North Dakota Geological Survey for collecting information on minerals.

By James H. Aase[1]

The value of mineral production in North Dakota was $272.1 million in 1977, a $28 million increase over that of 1976. Sand and gravel continued as the State's leading nonfuel mineral commodity in terms of value, followed in order by salt, lime, clays, and peat. The output value of all nonfuel minerals, except peat, showed an increase over that of 1976.

Fossil fuels and associated natural gas liquid products continued to play the dominant role, in terms of output value, of all mineral resources produced in the State. Production of crude petroleum, natural gas liquids, and coal increased in quantity and value over that of 1976. Natural gas production and value dropped slightly below the 1976 level.

In 1977, the mineral industry accounted for about 4% of the gross State product and employed about 1.7% of the State's work force. North Dakota's mineral industry was responsible for sizable amounts of revenue that accrued to State government. State income derived from gross production tax on oil and gas and the severance tax on coal was slightly over $17 million in fiscal year 1977. Additional income accrued to the State from the sale of mineral leases, royalty and rental payments, and other mineral-related sources.

The State refines about 70% of its oil production and consumes about 80% of its own coal production. The value added to minerals produced and processed within the State, and by the conversion of coal to electrical energy, and the refining of petroleum into its various products, is estimated at $624 million for 1977.

Activities associated with oil, gas, coal, and uranium exploration continued at an accelerated pace throughout the year. Three hundred sixty-five permits were issued for oil and gas exploration, 76 for coal, and 5 for uranium.

Oil and gas exploration efforts consisted of 2.7 million feet of drilling and the completion of 340 wells. Of the total wells completed, 106 were wildcats of which 29 were oil producers. No gas wells were completed. During the year 16 new oil pools were discovered. The State had 2,141 oil wells capable of production as of December 1, 1977.

Exploration test holes drilled for coal were estimated by the North Dakota Geological Survey at about 4,800 and the number drilled in uranium exploration at about 620.

Potash exploration was at a standstill during the year. No exploration permits were issued, and no test holes were reportedly drilled. The possibility of potash development in North Dakota was still awaiting decisions by two companies that drilled test holes in the State in 1976. Kalium Chemical, a subsidiary of PPG Industries, and Burlington Northern, Inc., which are exploring for potash jointly with CF Industries of Chicago, drilled test holes in Burke and Bottineau Counties during 1976. Although potash deposits were intersected in the drilling, company officials indicated that a number of other factors, besides the size of the deposits, need studying before the feasibility of a commercial operation can be determined.

The 45th Legislative Assembly of North Dakota was in session in 1977 and passed a number of bills affecting the State's mineral industry. Included in those enacted into law were measures raising base severance tax on coal mined in the State to 65 cents per ton and providing for incremental increases of 1 cent per ton for every point increase in the wholesale price index; requiring the Public Service Commission to issue a notice of noncompliance before suspending or revoking surface mine operator permits; clarifying current State laws on permits for surface mining; altering distribution formula for coal conversion tax; taxing large cooperative electrical transmission; allowing the State Water Commission to reserve final authority over any or certain categories of water permit application; and extending the application of the Energy Conservation and Transmission Siting Act to liquid transmission lines. Changes relating to the establishment of spacing units for oil and gas wells and the number of wells drilled therein were also made.

Table 1.—Mineral production in North Dakota[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Coal .... thousand short tons	11,102	$41,507	12,208	$48,495
Gem stones	NA	2	NA	2
Natural gas .... million cubic feet	31,470	10,699	29,173	10,303
Petroleum (crude) .... thousand 42-gallon barrels	21,725	170,411	23,273	186,184
Sand and gravel .... thousand short tons	5,171	8,345	5,821	12,102
Combined value of clays, lime, natural gas liquids, peat, and salt	XX	13,141	XX	14,980
Total	XX	244,105	XX	272,066
Total 1967 constant dollars	XX	87,756	XX	ᴾ134,292

ᴾPreliminary. NA Not available. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producer).

Table 2.—Value of mineral production in North Dakota, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	W	NA	
Barnes	$151	$198	Sand and gravel.
Billings	W	NA	
Bottineau	W	58	Sand and gravel, peat.
Bowman	W	W	Sand and gravel.
Burke	W	W	Do.
Burleigh	1,585	1,977	Do.
Cass	W	256	Do.
Dickey	28	79	Do.
Divide	W	54	Do.
Dunn	W	8	Do.
Eddy	826	W	Do.
Golden Valley	400	NA	
Grand Folks	W	220	Do.
Grant	W	NA	
Griggs	W	W	Do.
Kidder	W	W	Do.
McHenry	W	W	Do.
McKenzie	W	118	Do.
McLean	778	803	Do.
Mercer	W	NA	
Morton	W	W	Sand and gravel, clays.
Mountrail	W	NA	
Nelson	W	--	
Oliver	W	NA	
Pembina	W	W	Sand and gravel, lime.
Pierce	49	56	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in North Dakota, by county[1] [2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Ramsey	$23	--	
Ransom	W	$9	Sand and gravel.
Renville	W	NA	
Richland	W	W	Lime, sand and gravel.
Rolette	18	35	Sand and gravel.
Sheridan	10	--	
Slope	W	83	Do.
Stark	W	345	Do.
Stutsman	400	583	Do.
Towner	96	W	Do.
Traill	354	228	Do.
Walsh	170	212	Do.
Ward	W	1,321	Do.
Wells	118	190	Do.
Williams	45,703	W	Salt, sand and gravel.
Undistributed[3]	193,395	265,230	
Total[4]	244,105	272,066	

NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Benson, Cavelier, Emmons, Foster, Hettinger, Logan, La Moure, McIntosh, Sargent, Sioux, and Steele.

[2] Value of petroleum is based on an average price per barrel for the State.

[3] Includes gem stones, natural gas (1977), natural gas liquids (1977), petroleum (1977), coal (1977), and some sand and gravel which cannot be assigned to specific counties, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of North Dakota business activity

	1976	1977^{p}	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	280.0	291.0	+3.9
Unemployment do	10.0	14.0	+40.0
Employment (nonagricultural):			
Mining do	2.5	--	--
Manufacturing do	16.1	--	--
Contract construction do	15.8	--	--
Transportation and public utilities do	13.1	--	--
Wholesale and retail trade do	60.7	--	--
Finance, insurance, real estate do	9.1	--	--
Services do	41.1	--	--
Government do	56.2	--	--
Total nonagricultural employment do	214.6	--	--
Personal income:			
Total millions	$3,722	$4,044	+8.7
Per capita	$5,773	$6,190	+7.2
Construction activity:			
Number of private and public residential units authorized	6,097	6,486	+6.4
Value of nonresidential construction millions	$54.1	$93.2	+72.3
Value of State road contract awards do	$60.6	$39.6	-34.7
Shipments of portland and masonry cement to and within the State thousand short tons	422	439	+4.0
Mineral production value:			
Total crude mineral value millions	$244.1	$272.1	+11.4
Value per capita, resident population	$380	$417	+9.7
Value per square mile	$3,454	$3,850	+11.5

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and Federal Bureau of Mines.

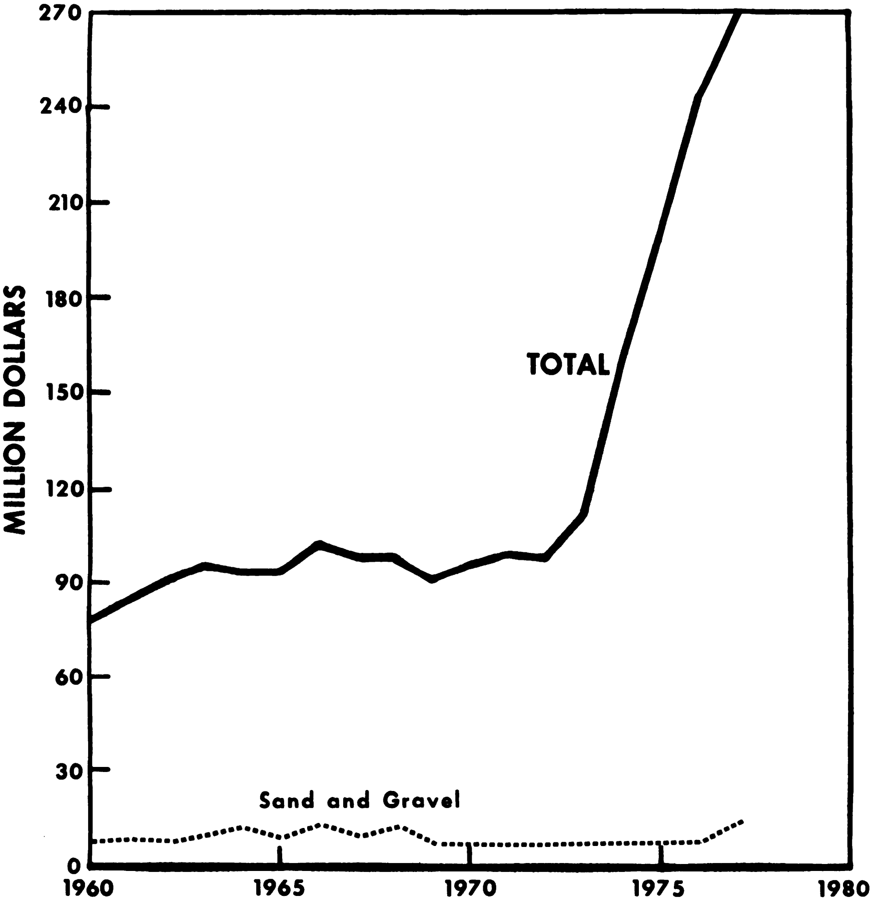

Figure 1.—Value of sand and gravel and total value of mineral production in North Dakota.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Production of clay and shale, used principally in the manufacturing of bricks and lightweight aggregate, increased substantially both in quantity and in value in 1977 compared with 1976 output.

The Hebron Brick Co. plant in Morton County is the State's only brick-manufacturing facility and has been in operation since 1904. The plant turns out over 1 million pieces of baked clay a month in approximately 50 different colors and varieties. Two basic types of clay are used: White sandy clay for light-colored bricks, and dark plastic clays for darker bricks. Both clays are mined at sites a few miles from the plant.

Lightweight aggregate made from local clay and shale is manufactured by U.S. Noonlite, Ltd., at Mandan. The lightweight aggregate is used principally in structural concrete works and concrete blocks.

Gem Stones.—All of the gem stone material produced in North Dakota results from the recreational activities of mineral collectors and other hobbyists.

The majority of gem stones found in the State are formed by the precipitation of silica from cold-water solutions. Moss agates are found in the gravels of the Yellowstone and Missouri Rivers in McKenzie and Williams Counties; petrified wood in Mesozoic and Tertiary formations in Billings, Adams, McLean, Morton, and Stark Counties; chalcedonic quartz in Stark and Hettinger Counties; agate in the Missouri River drainage throughout the south-central part of the State; and agatized fossil pine cones in the Upper Cretaceous Hell Creek Formation in Sioux County. In addition, "rosettes" or marcasite crystals are found in the Tertiary coalbeds in many places, and rhomboidal gypsum occurs in the Hell Creek Formation and in the Tertiary Ludlow Formation where they crop out in Morton County.

Lime.—Production of lime in 1977 decreased 15% in quantity but rose 22% in value. Quicklime produced by American Crystal Sugar Co. in Pembina County and Minn-dak Farmers Cooperative in Richland County comprise the State's total output, which was used principally in sugar refining. The limestone used in the calcining process to produce the quicklime is shipped into the State.

Peat.—Production of peat in North Dakota during 1977 showed little change from the 1976 output. Peat Products Co., accounted for the total State output, mined reed-sedge peat from an operation in Bottineau County. The entire production was used for horticultural purposes, including bulk quantities for general soil improvement and packaged quantities for use as ingredient for potting soil.

A principal resource area in the State for peat having characteristics that meet modern standards is northeast of the Turtle Mountains in Bottineau and Rolette Counties. Other areas of known peat occurrences border the Souris River bottom in McHenry County.

Salt.—Salt production in 1977 rose 43% in quantity and 46% in value. Hardy Salt Co. accounted for the total State output. All production was in Williams County by solution-mining methods. The salt produced was used in a variety of products, including table salt and water softener salt for home use, various trace mineral salt products for livestock, special salts for food processors, and brine and drilling salt used by the petroleum industry.

The resources of salt in North Dakota are extensive and are found in 11 principal beds ranging in age from Devonian to Jurassic. These beds underlie the western one-third of the State and occur at depths beneath the surface ranging from 3,600 feet in McHenry County to 12,570 feet in the deepest part of the Williston Basin. The total volume of salt in North Dakota has been estimated to be about 1,700 cubic miles. Current production is from the uppermost salt bed "A" of the Charles Formation of Mississippian Age, lying at a depth of 8,000 feet.

Sand and Gravel.—Production of sand and gravel in 1977 increased 13% in quantity and 45% in value compared with that of 1976. Output totaling 5.8 million tons valued at $12.1 million was produced from 64 operations located in 31 counties during 1977. Pembina was the leading county in production, followed in order by Ward, Burke, Burleigh, McLean, Eddy, and Stutsman Counties, which collectively account for 65% of the State total. Approximately 42% of the usage was for roadbase and covverings, 26% for concrete aggregate, 14% for fill, 13% for asphaltic concrete, 4% for concrete products, and the remainder for other uses.

Table 4.—North Dakota: Construction sand and gravel sold or used by producers

	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	2,249	$4,628	$2.06
Gravel	3,572	7,473	2.09
Total or average	5,821	[1]12,102	2.08

[1]Data do not add to total shown because of independent rounding.

Table 5.—North Dakota: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	1,540	$4,658	$3.02
Concrete products	213	673	3.16
Asphaltic concrete	747	1,571	2.10
Roadbase and coverings	2,471	4,035	1.63
Fill	823	1,080	1.31
Other	27	84	2.32
Total or average	5,821	[1]12,102	2.08

[1]Data do not add to total shown because of independent rounding.

Stone.—No stone production was reported in the State during 1977. Intermittently, glacial boulders, mostly of igneous origin, are utilized for concrete aggregate, road metal, and decorative purposes such as fireplaces. Erratics, usually collected from cultivated agricultural lands, are present throughout the glaciated portions of the State, which includes all but southwestern North Dakota. Scoria or clinker, a local term for baked clay formed by a naturally-occuring process whereby lignite strata burning in situ baked the overlying clay, is sometimes used as a road metal. Deposits of scoria are numerous and widespread in the nonglaciated southwest part of the State.

Sulfur.—Byproduct sulfur production in 1977 decreased in both quantity and value. The natural-gas-processing plant of Aminoil USA, Inc., at Tioga in Williams County, recovered elemental sulfur as a byproduct, which comprised the State's total output.

Vermiculite.—Vermiculite shipped into the State was exfoliated at the plant of Robinson Insulation Co. at Minot in Ward County. The exfoliated material was used as aggregate in concrete and plaster, block insulation, loose-fill insulation, soil conditioning, and other uses. The amount of material exfoliated in 1977 was down slightly in quantity, but value was higher than in 1976.

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[1]State Liaison Officer, Bureau of Mines, Bismarck, N. Dak.

Table 6.—Principal nonfuel mineral producers

Commodity and company	Address	Type of activity	County
Clays:			
Hebron Brick Co	Hebron, ND 58638	Pit and plant	Morton.
U.S. Noonlite, Ltd	Box 117 Mandan, ND 58554	do	Do.
Lime:			
American Crystal Sugar Co	101 North 3d St. Moorhead, MN 56506	Shaft kiln at beet sugar refinery.	Pembina.
Minn-dak Farmers Co-op	Wahpeton, ND 58075	do	Richland.
Peat:			
Peat Products Co	821 4th St. Bismarck, ND 58501	Bog	Bottineau.
Salt:			
Hardy Salt Co	Box 728 Williston, ND 58801	Brine well and plant	Williams.
Sand and gravel:			
Ames Sand & Gravel, Inc	Box 2702 Fargo, ND 58102	Pit	Burke.
Anderson Sand & Gravel	New Rockford, ND 58356	Pit	Eddy.
Dakota Sand & Gravel Co	Box 22 Bismarck, ND 58501	Pit	Burleigh.
Fisher Sand & Gravel	Box 1034 Dickinson, ND 58601	Pit	Various.
Jamestown Sand & Gravel Co	Ypsilanti, ND 58497	Pit	Stutsman.
Joe Mayo & Son	Box 310 Cavalier, ND 58220	Pit	Pembina.
Minot Sand & Gravel Co	Box 116 Minot, ND 58701	Pit	Ward.
Missouri River Sand & Gravel	Box 175 Bismarck, ND 58501	Pit	Burleigh.
Northern Improvement Co	Box 2846 Fargo, ND 58102	Pit and plant	Various.
Schriock Construction Co	RR 3, Radio City Minot, ND 58701	Pit	Ward.
Sheyenne Sand & Gravel, Inc	Box 178 Sheyenne, ND 58374	Pit	Eddy.
Susag Sand & Gravel	Crosby, ND 58730	Pit	Various.
Sulfur:			
Aminoil USA, Inc	Tioga, ND 58852	Plant	Williams.
Vermiculite, exfoliated:			
Robinson Insulation Co	Box 1782 Minot, ND 58701	do	Ward.

The Mineral Industry of Ohio

By Jacob N. Frank[1]

Ohio's mineral industry had a varied year for 1977, with increases in the production of coal, natural gas, crude petroleum, and all the industrial minerals except cement, clays, lime, and salt. The value of Ohio's mineral production in 1977 was $1,607 million, an increase of $172 million, or 12%, above the previous year. Nationally, the State continued to be a significant producer of clays, bituminous coal, lime, salt, and stone.

Ohio mineral production value was as follows: Coal, 53%; natural gas, 9%; petroleum, 8%; stone, 7%; lime, 7%; sand and gravel, 6%; portland cement, 4%; salt, 4%; clays, 1%; and all remaining commodities, less than 1%. Nonmetallic minerals, which were the second most valuable type of mineral produced in Ohio, generally increased in quantity and value, owing to increases in the production and value of sand and gravel and stone. Belmont County was the leading mineral-producing area in the State.

Table 1.—Mineral production in Ohio[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	155	$7,288	186	$8,875
Portland do.	2,130	65,656	1,970	65,899
Clays do.	4,288	14,704	3,568	12,835
Coal (bituminous) do.	46,582	773,699	47,918	848,074
Lime do.	3,788	114,299	3,199	111,100
Natural gas million cubic feet	88,891	90,491	99,327	138,760
Peat thousand short tons	3	121	15	107
Petroleum (crude) thousand 42-gallon barrels	9,994	117,655	10,359	136,281
Salt thousand short tons	5,052	66,332	3,701	63,485
Sand and gravel do.	38,876	76,730	46,521	100,736
Stone do.	42,699	106,996	45,001	119,966
Combined value of abrasives, gem stones, and gypsum	XX	1,925	XX	1,336
Total	XX	1,435,896	XX	1,607,454
Total 1967 constant dollars	XX	516,205	XX	[p]793,439

[p] Preliminary. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Ohio, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	W	W	Stone.
Allen	$1,898	$2,394	Do.
Ashland	W	W	Sand and gravel, clays.
Ashtabula	W	W	Lime, sand and gravel.
Athens	W	W	Stone, sand and gravel.
Auglaize	W	W	Sand and gravel, stone, clays.
Belmont	W	W	Sand and gravel, stone.
Brown	167	W	Stone, sand and gravel.
Butler	5,037	5,171	Sand and gravel.
Carroll	W	362	Stone, sand and gravel.
Champaign	W	W	Sand and gravel, peat.
Clark	W	W	Sand and gravel, stone.
Clermont	W	W	Do.
Clinton	983	W	Stone.
Columbiana	W	W	Sand and gravel, clays, stone.
Coshocton	W	W	Sand and gravel, stone.
Crawford	W	W	Stone.
Cuyahoga	21,973	W	Salt, lime, clays, peat.
Darke	W	942	Sand and gravel.
Defiance	2	4	Do.
Delaware	2,045	2,618	Stone, clays.
Erie	W	W	Lime, stone, sand and gravel.
Fairfield	W	W	Sand and gravel.
Fayette	W	W	Stone.
Franklin	W	W	Sand and gravel, stone, clays.
Gallia	W	W	Sand and gravel.
Geauga	W	W	Sand and gravel, stone.
Greene	22,689	25,385	Cement, sand and gravel, stone, clays.
Guernsey	W	W	Stone.
Hamilton	6,783	8,992	Sand and gravel.
Hancock	W	W	Stone, lime.
Hardin	W	W	Stone.
Harrison	W	W	Stone, clays.
Henry	203	W	Sand and gravel, clays.
Highland	W	1,747	Stone, sand and gravel.
Hocking	W	282	Sand and gravel, clays.
Holmes	8,637	W	Stone, sand and gravel, clays.
Huron	W	W	Sand and gravel, stone.
Jackson	18,521	W	Clays, stone, sand and gravel.
Jefferson	W	1,607	Clays.
Knox	W	W	Sand and gravel, stone.
Lake	W	W	Salt, lime, sand and gravel.
Lawrence	10,504	10,121	Cement, clays, sand and gravel, stone.
Licking	W	W	Sand and gravel, clays.
Logan	939	W	Stone, sand and gravel, peat.
Lorain	W	17,684	Lime, stone, sand and gravel, grindstone.
Lucas	W	W	Stone, cement, sand and gravel, clays.
Madison	W	W	Stone, sand and gravel.
Mahoning	W	W	Stone, clays, sand and gravel, peat.
Marion	2,138	2,462	Stone, sand and gravel, clays.
Medina	W	W	Sand and gravel, clays, stone.
Meigs	W	4,415	Sand and gravel.
Mercer	W	W	Stone.
Miami	4,708	4,476	Stone, sand and gravel.
Monroe	W	W	Stone.
Montgomery	W	W	Sand and gravel, stone.
Morgan	W	W	Do.
Morrow	164	184	Sand and gravel.
Muskingum	W	W	Cement, stone, sand and gravel, clays.
Noble	W	W	Stone, clays.
Ottawa	W	W	Stone, lime, gypsum.
Paulding	W	W	Cement, stone, clays.
Perry	33,927	W	Stone, sand and gravel, clays.
Pickaway	W	W	Sand and gravel, stone.
Pike	W	W	Do.
Portage	6,491	7,698	Sand and gravel.
Preble	W	W	Sand and gravel, stone.
Putnam	W	603	Stone, clays.
Richland	W	W	Sand and gravel, clays, peat.
Ross	W	W	Sand and gravel, stone.
Sandusky	61,388	64,624	Lime, stone.
Scioto	W	W	Sand and gravel, stone, clays.
Seneca	W	W	Lime, stone, clays.
Shelby	W	W	Stone, sand and gravel.
Stark	15,609	W	Sand and gravel, stone, clays, cement.
Summit	W	W	Salt, sand and gravel, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Ohio, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Trumbull	W	W	Sand and gravel, stone.
Tuscarawas	W	W	Sand and gravel, clays, stone.
Union	W	W	Stone.
Van Wert	W	$1,353	Do.
Vinton	W	8	Clays.
Warren	W	W	Sand and gravel, stone.
Washington	W	925	Do.
Wayne	$27,056	26,070	Salt, sand and gravel, stone, clays.
Williams	662	W	Sand and gravel, peat.
Wood	2,708	3,253	Stone.
Wyandot	W	w	Stone, lime, sand and gravel, clays, peat.
Undistributed[2]	1,180,659	1,414,079	
Total[3]	1,435,896	1,607,454	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Fulton County is not listed because no production was reported. County data for coal, natural gas, and petroleum values are unavailable; totals are included with "Undistributed."

[2] Includes coal, natural gas, petroleum, gem stones, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Ohio business activity

		1976	1977[p]	Change, percent
Employment and Labor force, annual average:				
Total civilian labor force	thousands	4,731.0	4,811.0	+1.7
Unemployment	do	369.0	311.0	-15.7
Employment (nonagricultural):				
Mining	do	28.2	28.4	+.7
Manufacturing	do	1,295.3	1,340.5	+3.5
Contract construction	do	154.2	160.5	+4.1
Transportation and public utilities	do	890.8	918.3	+3.1
Finance, insurance, real estate	do	177.0	183.7	+3.8
Services	do	703.2	728.0	+3.5
Government	do	632.2	637.1	+.8
Total nonagricultural employment	do	4,094.6	4,215.5	+3.0
Personal income:				
Total	millions	$68,420	$75,809	+10.8
Per capita		$6,400	$7,084	+10.7
Construction activity:				
Number of private and public residential units authorized		48,660	60,844	+25.0
Value of nonresidential construction	millions	$917.9	$984.9	+7.3
Value of State road contract awards	do	$188.5	$200.0	+6.1
Shipments of portland and masonry cement to and within the State	thousand short tons	2,992	3,422	+14.4
Mineral production value:				
Total crude mineral value	millions	$1,435.9	$1,607.5	+11.9
Value per capita, resident population		$134	$150	+11.9
Value per square mile		$34,833	$38,995	+11.9

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

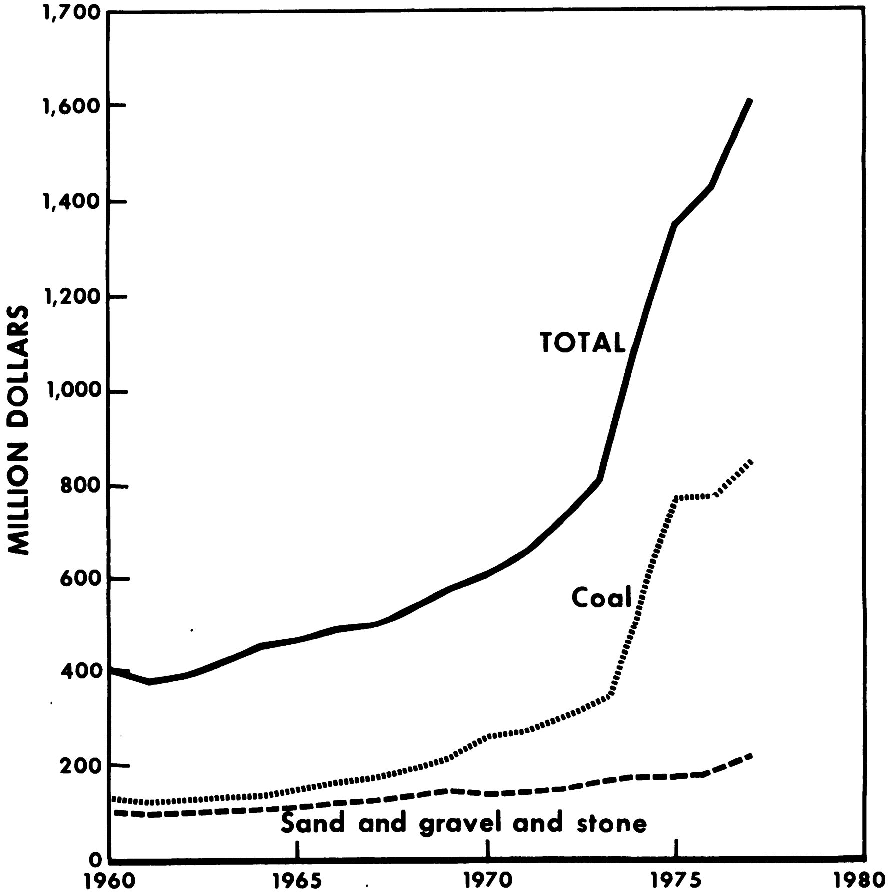

Figure 1.—Value of coal, sand and gravel, stone, and total value of mineral production in Ohio.

Legislation and Government Programs.—During 1976, the Ohio General Assembly enacted the following laws that directly or indirectly affect the mineral industry:

1. Amended Substitute House Bill 415, which became effective December 14, 1977, established a State Department of Energy and assigned to it all functions of the Ohio Energy and Resource Development Agency (ERDA). The new department assumed the duties for energy-related planning and was required to adopt rules governing allocation priorities among users of coal and petroleum fuels. The Public Utilities Commission of Ohio was required to develop priorities for curtailment of electricity and natural gas service in the event of shortages. The act required the department, with the approval by the Governor, to adopt energy emergency rules, whereunder, during an energy emergency (1) use of energy or transportation may be restricted; (2) civil defense, police, and emergency medical supplies may be mobilized; and (3) the Governor may order the sale of fuel or power supplies by utilities and wholesale or retail suppliers or the imposition of other energy conservation, production, or distribution measures. The act prohibited violation of an energy emergency order, imposed penalties, and established procedures for declaring and terminating energy emergencies. Qualifications for appointment of the Director of

Energy are prescribed, and anyone who is appointed as director, assistant director, or a division chief is required to divest himself or herself of direct financial interests in certain energy-related businesses, and are prohibited from representing others before the State within 2 years after leaving office.

The act levied through 1981 an excise tax on the use of 200 or more tons of coal in any calendar year for generating electricity or steam, at a graduated rate of $0.15 to $0.40 per ton. The tax was levied to finance coal-related research and facilities and, during the 1978-1979 fiscal biennium, up to 10% of the revenue from the tax could be used for paying the Department of Energy's operating expenses. A Coal Research and Development Commission was to be established on January 1, 1982; and a personal property tax exemption for certain coal conversion facilities was repealed.

The act also affected the Public Utilities Commission of Ohio. Its chief executive officer, the Chair, was given authority to appoint and remove its staff. The act required gas companies that purchase gas produced by a coal conversion facility constructed with Federal assistance before 1983, to purchase such coal gas on a cost-of-production-plus-reasonable-profit basis, and required the gas companies to roll in the price of such coal gas to their customers, in accordance with the Public Utilities Commission of Ohio rules. The State Board of Regents was required to create an Inter-University Energy Research Council. The act also enabled the Ohio Water Development Authority (OWDA) to construct and finance energy resource development facilities, added the Director of Energy to OWDA, added members to the Power Siting Commission, and repealed revenue bonding and related powers of Ohio ERDA (now the Ohio Department of Energy).

2. Amended Substitute House Bill 244 became effective November 4, 1977. The act enabled the State to reclaim or share landowners' costs for the reclamation of privately owned, unreclaimed lands (mined or licensed to be mined before April 10, 1972) that caused water pollution or damage to adjacent property. The act required the landowner to reimburse the State for any substantial increase in his or her property's market value that is attributable to such reclamation. Rules and procedures were set out whereby the Chief of the Division of Reclamation could issue permits for the mining and reclamation requirements of such unreclaimed lands, and could modify certain reclamation lands. Control over the funding of State reclamation projects was transferred from the Controlling Board to the Board on Unreclaimed Strip-Mined Lands.

3. Amended Substitute House Bill 261, which became effective November 18, 1977, required each gas, natural gas, or electric light company to file with the Public Utilities Commission an annual forecast of its service demands, fuel supply, fuel purchase contracts, and related information, each July 1 and November 1. The act required the Ohio Energy and Resource Development Agency to submit a summary analysis of the reports to the General Assembly by August 15 and November 15 of each year.

4. Amended Substitute Senate Bill 303 was signed by the Governor November 15, 1977. The act enabled a consortium or group of local governments and a private firm engaged in the business of operating resource recovery facilities jointly to obtain Ohio Water Development Authority (OWDA) financing for facilities to recover resources from solid waste. The contract under which the OWDA helps finance a solid waste facility may include provisions for the operation, eventual sale, and disposition of the facility. OWDA is prohibited from entering such a contract if the proposed acquisition or construction would undermine the financial feasibility of another OWDA-local government solid waste project. To retire OWDA bonds, the act permitted the use of rental or other user charges to be paid to a facility's private operator for use of the facility by the local governments served. The act also revised related competitive bidding provisions, and required boards of county commissioners to hold at least three public hearings before setting rates or charges for garbage and refuse collection or disposal services, or entering into a contract that sets rates or charges for such services.

The protection of mineral resources, along with other critical resource areas, was recommended by the Ohio Land Use Review Committee. The committee spent 2 years studying land-use problems and hearing testimony at 19 hearings in various locations throughout Ohio. In its report to the Ohio General Assembly, the committee of legislators noted that it is imperative to identify and protect these areas because many of them are threatened by changing land-use patterns and the pressures of continuous population shifts.

The Ohio Department of Taxation severance tax revenue for the fiscal year ending June 30, 1977, was $3,910,872 compared with $3,925,790 collected in fiscal year 1976. The severance tax, first levied in 1972, is paid by persons or firms that extract or sever certain natural resources from the soil or waters of Ohio. The tax produced about $3.9 million of General Fund revenue in fiscal year 1977, about 47% of it from the levy on coal. The tax rates for the natural resources are as follows: Coal, 4 cents per ton; salt, 4 cents per ton; limestone or dolomite, 1 cent per ton; sand and gravel, 1 cent per ton; oil, 3 cents per barrel; and natural gas, 1 cent per 1,000 cubic feet. The severance tax revenue collected in fiscal year 1977 was as follows: Coal, $1,826,011; natural gas, $879,083; limestone, $337,348; gravel, $204,571; oil, $266,084; salt, $167,811; sand, $156,169; and dolomite, $73,795. The unreclaimed land fund received 75% of the monies collected and the oil and gas well plugging fund received 25% of the monies.

The Ohio Division of Reclamation licensed 205 operators and issued 525 permits under the coal strip mining regulation program during 1977. A total of 15,581 acres was bonded by coal operators and about 22,843 acres were affected by mining operations. The division approved grading work for partial release of bond on 852 acres, and the remaining bond was released for completion of planting work on 1,757 acres. Under the surface mining program for industrial minerals, the division issued 512 permits totaling 38,238 acres, but only 2,181 acres were bonded for mining. Surface mining permits were issued for surface mining operations in every county (88) in Ohio.

The Ohio Division of Geological Survey published Report of Investigation No. 100, Silurian Rocks in the Subsurface of Northwestern Ohio; Report of Investigation No. 101, Glacial Geology of Ashland County, Ohio; Report of Investigation No. 103, Trace Elements in Ohio Coals; and Report of Investigation No. 104, The Occurrence of Sulfide and Associated Minerals in Ohio. Also released by the division was the Mineral Industries Map of Ohio; Geological Note No. 5, Limestone in the Tymochtee Dolomite; and the leaflet, Geology in Land-Capability Analysis.

Employment and Injuries.—In 1977, Federal coal mine inspectors from the Mining Enforcement and Safety Administration conducted 2,739 inspections and investigations at Ohio coal mines. There were 835 regular safety and health inspections; 943 spot inspections; 308 follow-up inspections; and 653 other investigations, including those for accidents, accident prevention, electrical and technical faults, and complaints. Federal metal and nonmetal mine inspectors performed a total of 795 regular inspections and 620 spot inspections at clay, cement, stone, sand and gravel, peat, gypsum, and salt operations.

Ohio's mining industry recorded a total of eight fatalities during 1977, five fatalities in the coal industry, and three in the industrial mineral industry. The five fatalities in the coal industry for 1977 was one less than 1976. The frequency rate for 1977 was 0.11 per million tons of coal produced. Three of the fatalities occurred in underground mines, and two occurred at surface mines. The three industrial mineral industry fatalities in 1977 was one more than in 1976. Two fatalities were in the limestone industry and one in the sand and gravel industry.

The Ohio Division of Mines' Deputy Mine Inspectors conducted 4,887 inspections of coal and nonmetallic mining and quarrying operations and spent 707 days in the oilfields witnessing the plugging and cementing of abandoned oil and gas wells.

The average annual employment for the nonfuel mineral industry was 5,852 workers. A total of $73,224,499 was paid in wages, which averages $12,513 per worker for 1977.

The Portland Cement Association awarded its safety trophy to the Medusa Cement Co., Toledo, Ohio, for completing the year without a lost-time accident.

The National Limestone Institute, Inc., awarded Special Safety Certificates to the France Stone Co.'s Paulding Quarry and Silica Plant for 6 consecutive years without a disabling injury; to the France Stone Co.'s Flat Rock Quarry for 5 consecutive years without a disabling injury; and to France Stone Co.'s Keeport Quarry and the Ostrander mine of the Owens Stone Co., Inc., for 4 consecutive years without a disabling injury.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives.—Cleveland Quarries Co. produced abrasive stone (grindstone) as a byproduct of sandstone quarrying at its South Amherst Quarries, Lorain County. Production and value of production of abrasive stone increased over that of 1976. Manufactured abrasives such as iron and steel shot and grit are also produced in Ohio.

Cement.—Portland cement was produced at five plants, four of which also produced masonry cement. The production of portland cement decreased 11% to 1,955,679 tons and shipments decreased 8% to 1,969,984 tons. Stocks of portland cement at yearend 1977 were 187,038 tons, 12% less than in 1976. Value of portland cement shipments in 1977 increased slightly to $65.9 million, and the average value per ton increased 8% to $33.45 compared with $30.83 in 1976. Type I (general construction use) and Type II (moderately low-heat use and moderate degree of resistance to sulfate attack) composed 97% of the portland cement shipped; all other types combined composed only 3% of the shipments.

Table 4.—Ohio: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	7	5
Production	2,189,725	1,955,679
Shipments from mills:		
Quantity	2,129,722	1,969,984
Value	$65,655,524	$65,899,047
Stocks at mills, Dec. 31	212,405	187,038

Table 5.—Ohio: Masonry cement salient statistics

(Short tons)

	1976	1977
Number of active plants	4	4
Production	156,927	183,741
Shipments from mills:		
Quantity	155,141	185,951
Value	$7,287,542	$8,875,250
Stocks at mills, Dec. 31	14,626	13,909

Disposition of portland cement shipped by Ohio manufacturers was as follows: 67% to ready-mix concrete producers; 17% to concrete product manufacturers for concrete blocks, concrete pipes, precast prestressed concrete, and other concrete products; 8% to building material dealers; 5% to highway contractors; and 3% to other contractors, government agencies, and miscellaneous customers.

Masonry cement production increased 17% to 183,741 tons and shipments increased 20% to 185,951 tons in 1977. Stocks of masonry cement at yearend 1977 were 13,909 tons, 717 tons less than those of 1976. Value of masonry cement shipments in 1977 increased 22% to $8.9 million, and the average value per ton increased $0.76 to $47.73 compared with $46.97 per ton in 1976.

Clays.—Combined clay and shale production totaled 3,568,000 tons valued at $12,835,000, a decrease in both quantity and value from that of 1976. Total clay production in 1977 consisted of 2,842,000 tons of common clay and shale with a value of $6.2 million and 726,000 tons of fire clay valued at $6.6 million. The average unit value per ton of common clay was $2.18, a decrease of $0.43 from 1976, and the average unit value of fire clay was $9.09, an increase of $1.48 from 1976. Ohio ranked third in the Nation in clay production.

Clay and shale was produced from 93 mines operated by 65 companies in 33 counties. Nine companies with 24 mines accounted for 60% of the State's common clay and shale and 37% of the fire clay. Among the leading producers were Belden Brick Co., Medusa Cement Co., Hydraulic-Press Brick Co., Southwest Portland Cement Co., Swank Refractories Co., and Marquette Cement Manufacturing Co.

Seven counties—Tuscarawas, Stark, Greene, Lawrence, Perry, Marion, and Paulding—produced 66% of the common clay and shale output. Two counties, Jackson and Jefferson, produced 50% of the fire clay output.

About 51% of common clay and shale production was used to manufacture building brick; 20%, in manufacturing cement; 13%, for drain tile; 11%, for sewer pipe; and 5%, for concrete blocks, flue linings, pottery, and various ceramic uses. Fire clay uses were as follows: 49%, firebrick, blocks, and shapes; 21%, refractory mortar and cement; 15%, foundry sands; and 15% for glazes, glass, enamels, pottery, flue linings, and various ceramic uses.

Gem Stones.—Gem and mineral specimen collectors were active in southeastern Licking County searching for flint, the State's official gem stone. Other specimens being sought were calcite, celesite, and jasper. Value of specimens collected remained approximately the same as in 1976.

Graphite (Synthetic).—Graphite shapes were produced from petroleum and pitch coke by the Ohio Carbon Co. at Cleveland, Ohio. Output and value increased above those of 1976.

Gypsum.—Crude gypsum production from Ohio's open pit gypsum mine in Ottawa County decreased 36% from 1976. Gypsum was calcined by Celotex Corp. and United States Gypsum Co. at plants in Ottawa County, and by the National Gypsum Corp. in Lorain County. Production of calcined gypsum was 368,000 tons, 7% less than in 1976.

Lime.—Ohio ranked first in lime production and consumption in the Nation. Sixteen companies were involved in the production of lime at 16 plants in 10 counties. The counties that had significant lime production were Sandusky, Lorain, Lake, Erie, Cuyahoga, and Seneca. Leading producers were Martin Marietta Chemicals, United States Steel Corp., Republic Steel Corp., and Huron Lime Co. Lime production in 1977 decreased 16% to 3,199,000 tons, and the value of the production decreased 3% to $111,100,000. The major uses of lime were for steelmaking in basic oxygen furnaces (BOF), 55%; refractory dolomite, 17%; glass, 6%; steelmaking in electric furnaces, 3%; finishing lime, 2%; sewage treatment, 1%; and other uses, including mason's lime and agriculture, 16%.

Table 6.—Ohio: Lime sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Steel, BOF	1,892	$55,520	1,756	$59,123
Refractory dolomite	581	20,887	530	20,838
Glass	189	5,715	199	6,696
Steel, electric	90	2,728	94	3,180
Finishing lime	79	2,617	79	2,945
Sewage treatment	36	1,087	42	1,413
Mason's lime	34	1,139	W	W
Agriculture	12	510	W	W
Other uses[1]	876	24,095	499	16,905
Total[2]	3,788	114,299	3,199	111,100

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes magnesite, calcium carbide, other chemical uses, open-hearth steel furnaces, water purification, sugar refining, soil stabilization, fertilizer, other construction lime, other metallurgy (1976), rubber (1976), and uses indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

The Ohio Lime Co. completed a major plant modernization and expansion project in 1977 at Woodville, Ohio. The company operates a multi-project lime plant utilizing company-owned dolomitic limestone resources of extremely high purity.

In 1977, the Diamond Shamrock Corp. shut down its Painesville, Ohio, chemical works, including the lime plant, because of the loss of sales to natural soda ash and the rising costs for energy and pollution control.

Peat.—Prior to 1977, the Bureau of Mines classified peat as a fuel. However, to more closely align peat with the Standard Industrial Classification grouping, and because peat has traditionally been used for other than fuel purposes in the United States, the Bureau began classifying it as a nonmetal in mid-1977. Eight companies harvested peat in eight counties. The peat produced was of the humus and moss type. Sales of peat totaled 14,650 tons at a value of $106,909, an increase in sales of 388% over 1976, but a decrease in value of 12% compared with the previous year. Two companies packaged peat while the other six companies sold theirs in bulk form. Most of the peat was used in bulk form for general soil improvement.

Perlite (Expanded).—Crude perlite, mined in the western states, was expanded at four plants: The United States Gypsum Co. plant in Ottawa County; the National Gypsum Co. plant in Lorain County; the Celotex Corp. plant in Hamilton County; and the Cleveland Gypsum Co. plant in Cuyahoga County. The quantity of expanded perlite sold or used was 12,977 tons, 11% above that of 1976. The total value increased from $952,000 in 1976 to $1,012,000 in 1977, an increase of 6% in value. Average value per ton decreased to $77.99 compared with $81.34 in 1976. The principal uses for perlite in Ohio were for plaster aggregate, various formed products, insulation, and miscellaneous industrial uses.

Quartz Crystal (Cultured).—Ohio is the Nation's leading producer of cultured quartz crystal. Production for 1977 decreased 29% and value decreased 8% from 1976 figures. Three companies produced cultured quartz crystal: Sawyer Research Products, Inc. at Eastlake in Lake County, Bliley Electric Co. at Cortland in Trumbull County, and Crystal Systems, Inc., at Chardon in Geauga County all produced cultured quartz crystals for all types of electronic communications equipment, for color oscillators in color television, for digital quartz watches, and for citizen's band radios. Sawyer Research Products Inc. completed an expansion of company facilities in 1977.

Salt.—Ohio ranked fifth in national output of salt. Production (as measured by quantity sold or used) decreased 27% below that of 1976, to a total of 3.7 million tons. Two underground mines and four salt plants were producing. The value of salt in Ohio decreased 4% to $63.5 million in 1977. The average value of salt increased $4.02 per ton to $17.15, compared with $13.13 in 1976. Four companies with six operations located in four counties sold or used salt in the form of rock, brine, and evaporated brine. Underground mines in Cuyahoga and Lake Counties extracted rock salt, while brine was pumped from wells in Lake, Summit, and Wayne Counties. Evaporated salt producers used both the open-pan and vacuum processes to recover a high-purity, finely crystalline salt from brine. Ohio's rock salt output was used mainly for control of ice on highways and for chemical applications. Evaporated salt was used for a wide variety of applications, which included human and animal consumption.

Sand and Gravel.—Ohio's sand and gravel operations mined 46.5 million tons of construction and industrial sand and gravel, valued at $100.7 million, an increase of 19% in quantity and 31% in value over the previous year.

Construction sand and gravel accounted for 98% of Ohio's total sand and gravel output and 92% of the total sand and gravel value. The total production of 45.4 million tons of construction sand and gravel consisted of 19.9 million tons of sand with a unit value of $1.94 per ton, and 25.6 million tons of gravel with a unit value of $2.10 per ton. The principal uses for construction sand and gravel were 45% for concrete aggregate, 19% for asphaltic concrete aggregate, 15% for roadbases, 14% for fill, 5% for concrete products, and 2% for other uses.

Industrial sand and gravel accounted for 2% of the total sand and gravel output and 8% of the total value. The principal uses for industrial sand and gravel were for molding sand, foundry sand, glass manufacturing, and various metallurgical and industrial uses.

The average unit value of Ohio's sand and gravel (construction and industrial) increased $0.20, from $1.97 per ton in 1976 to $2.17 per ton in 1977.

Table 7.—Ohio: Construction sand and gravel sold or used, by major use category

	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential,highways, bridges, dams, waterworks, airports, etc.)	14,089	$28,429	$2.02	20,237	$43,805	$2.16
Concrete products (cement blocks, bricks, pipe, etc.)	2,850	5,842	2.05	2,305	5,259	2.28
Asphaltic concrete aggregates and other bituminous mixtures	11,494	22,857	1.99	8,830	18,407	2.08
Roadbase and coverings	3,613	6,491	1.80	6,964	14,060	2.02
Fill	4,570	6,183	1.35	6,224	8,821	1.42
Other uses	1,172	1,375	1.17	884	1,864	2.11
Total[1] or average	37,790	71,176	1.88	45,448	92,224	2.03

[1] Data may not add to totals shown because of independent rounding.

Table 8.—Ohio: Sand and gravel sold or used by producers, by use

Use	1976 Quantity (thousand short tons)	1976 Value (thousands)	1976 Value per ton	1977 Quantity (thousand short tons)	1977 Value (thousands)	1977 Value per ton
Construction:						
Sand	19,164	$31,318	$1.63	19,858	$38,507	$1.94
Gravel	18,625	39,859	2.14	25,589	53,716	2.10
Total[1] or average	37,790	71,176	1.88	45,447	92,223	2.03
Industrial:						
Sand	940	4,911	5.22	W	W	W
Gravel	146	643	4.40	W	W	W
Total or average	1,086	5,554	5.11	1,073	8,513	7.93
Grand total[1] or average	38,876	76,730	1.97	46,521	100,736	2.17

W Withheld to avoid disclosing company proprietary data; included in total.

[1] Data may not add to totals shown because of independent rounding.

Table 9.—Ohio: Sand and gravel sold or used by producers, by county

(Thousand short tons and thousand dollars)

	1976 Number of plants	1976 Quantity	1976 Value	1977 Number of plants	1977 Quantity	1977 Value
Ashland	4	158	286	3	180	350
Ashtabula	6	117	174	4	255	421
Athens	4	145	375	4	271	574
Auglaize	4	427	819	2	381	708
Butler	12	2,957	5,037	10	2,854	5,171
Champaign	4	235	428	3	254	464
Clark	8	995	1,727	8	1,112	1,973
Columbiana	4	199	392	4	125	321
Coshocton	6	385	647	4	536	1,000
Darke	4	375	816	4	393	942
Defiance	1	2	2	1	2	4
Erie	6	86	322	4	114	379
Franklin	10	2,681	5,281	9	2,721	5,375
Geauga	6	1,089	3,786	6	867	2,616
Greene	10	801	1,360	10	1,110	2,136
Hamilton	16	3,743	6,783	16	4,402	8,992
Henry	1	81	194	1	68	170
Highland	1	23	65	1	21	31
Jackson	1	19	77	1	16	88
Knox	5	671	1,315	6	1,015	4,233
Licking	7	582	937	7	593	1,038
Logan	4	211	344	4	267	451
Lucas	3	475	790	1	555	903
Marion	5	308	529	4	232	505
Medina	8	923	1,676	7	895	1,689
Meigs	4	1,728	3,734	4	1,835	4,415
Miami	9	744	1,433	8	763	1,414
Montgomery	12	1,919	3,543	10	1,987	3,785
Morrow	1	93	164	1	98	184
Pickaway	3	375	634	2	379	667
Pike	4	297	582	4	337	652
Portage	25	2,802	6,491	25	3,465	7,698
Richland	6	594	1,131	9	715	1,373
Ross	8	777	1,983	6	496	1,185
Scioto	4	257	522	2	436	860
Shelby	6	409	537	3	280	507
Stark	13	1,643	3,708	11	1,888	4,546
Summit	19	1,402	2,710	16	1,412	2,962
Tuscarawas	11	1,351	2,473	10	1,498	3,136
Warren	10	1,704	3,181	9	1,474	2,991
Washington	6	454	875	5	372	846
Wayne	4	514	969	4	560	1,046
Williams	5	365	658	3	426	752
Wyandot	4	205	335	7	400	714
Other counties[1]	38	3,555	6,908	32	8,452	20,473
Total[2]	332	38,876	76,730	295	46,521	100,736

[1] Includes Belmont, Brown, Carroll, Clermont, Clinton (1976), Fairfield, Gallia, Hocking, Holmes, Huron, Lake, Lawrence, Lorain, Madison, Mahoning (1976), Morgan, Muskingum, Perry, Preble, and Trumbull.

[2] Data may not add to totals shown because of independent rounding.

Sand and gravel was produced in 63 counties at 295 operations. Output exceeded 1 million tons in 13 counties; Hamilton County was the leading producer with 4.4 million tons, followed by Portage County with 3.5 million tons, Butler County with 2.9 million tons, and Franklin with 2.7 million tons. Four mines produced 1 million tons or more each; four mines produced between 700,000 and 1 million tons each; seven mines produced between 400,000 and 700,000 tons each; 58 mines produced between 200,000 and 400,000 tons each; 72 mines produced between 100,000 and 200,000 tons each; 50 mines produced between 50,000 and 100,000 tons each; 48 mines produced between 25,000 and 50,000 tons each; and 80 mines produced less than 25,000 tons each. The largest producers of construction and industrial sand and gravel were Dravo Corp.'s Ohio Gravel Co. with 7 mines, American Gravel Corp. with 14 mines, and Twin Lakes Sand Co. with 6 mines.

Slag (Iron-Blast-Furnace).—Production of iron-blast-furnace slag totaled 6 million tons valued at $17.8 million, according to the National Slag Association. Production increased 4% and value increased 7% over 1976 figures. The average unit value increased $0.09, from $2.85 per ton in 1976 to $2.94 per ton in 1977.

Screened air-cooled slag comprised 83.6% of the total processed material; granulated and expanded slag made up the remainder. Air-cooled slag was used chiefly as aggregate for concrete and bituminous construction and highway and airport construction. Granulated slag was used in highway construction, soil conditioning, and in the manufacture of cement. The chief use for expanded slag was as aggregate in concrete block and lightweight concrete.

Stone.—Production of stone totaled 45 million tons with a value of $120 million. Compared with 1976 figures, production quantity increased 5.4% and the value of the stone produced increased 12%.

Ohio led all States in production of dimension sandstone; it ranked third in production of dimension stone and dimension limestone; and it was fifth in crushed sandstone. The average value of all crushed and broken stone increased 16 cents per ton to $2.60; the average value of dimension stone was $24.12 per ton; and the average value of total stone was $2.67 per ton. Eight companies quarried dimension stone at 27 quarries for rubble (40%), sawed stone (26%), rough blocks (20%), and other uses (14%). Production increased to 147,500 tons valued at $3.56 million. Leading producers were Standard Slag Co., Blazer Materials Co., and Briar Hill Stone Co.

Crushed stone was produced by 105 companies at 148 quarries for concrete aggregate, roadstone and roadbase aggregate, and other uses. Production increased 5% to 44.85 million tons valued at $116.4 million. The average value of crushed stone was $2.59 per ton. Leading producers of crushed stone were National Lime & Stone Co., The France Stone Co., and the Standard Slag Co.

The principal uses for crushed and broken limestone and dolomite were for roadbase and paving materials, concrete aggregate, flux stone, cement and lime manufacturing, agricultural uses, riprap and jettystone applications, manufacture of deadburned dolomite, railroad ballast, glass manufacture, and various miscellaneous chemical and industrial uses.

Crushed and broken quartzite and sandstone were used in refractory applications, aggregate, glass manufacture, flux stone, and various miscellaneous uses. Dimension sandstone was used as sawed stone, rough blocks, and rubble. Dimension limestone was used for rubble.

The Flintkote Co.'s Diamond Quarry, Middlebranch, Ohio, did not operate during 1977. Silica Inc., Twinsburg, Ohio, went bankrupt and was purchased by former officers of the company. All assets of MCQ Industries, including the Marble Cliff Quarry and plants at Trabue-Dublin Rd., Columbus, Ohio, the Shawnee Quarry in Delaware County, and plants in Westerville and Worthington, Ohio, were acquired by Medusa Aggregates Co., a division of Medusa Corp.

Table 10.—Ohio: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	6,359	13,990	7,247	16,530
Roadstone	4,232	9,305	6,699	15,870
Dense-graded roadbase stone	4,279	9,581	4,639	11,180
Macadam aggregate	5,085	11,170	4,195	9,494
Lime manufacture[2]	4,273	7,708	3,949	7,349
Bituminous aggregate	2,712	5,957	3,841	9,182
Flux stone	3,673	8,760	3,461	8,679
Cement manufacture	3,414	8,334	2,921	8,237
Surface treatment aggregate	2,082	4,749	2,214	5,458
Agricultural limestone	2,153	6,137	1,692	5,370
Railroad ballast	963	1,851	977	2,067
Glass manufacture	851	5,843	904	6,534
Riprap and jetty stone	1,084	2,600	761	2,077
Refractory stone	356	1,671	366	1,704
Other filler	241	2,621	280	3,121
Filter stone	64	119	73	135
Disinfectant and animal sanitation	10	18	--	--
Other uses[3]	780	3,644	631	3,417
Total[4]	42,612	104,060	44,853	116,410

[1] Includes limestone and sandstone.

[2] Includes dead-burned dolomite and chemical stone.

[3] Includes stone used in soil conditioners, asphalt filler, porcelain, pottery and tile, mine dusting, mineral food (1976), whiting, roofing granules (1977), ferrosilicon (1977), sulfur dioxide (1977), fill (1977), terrazzo and exposed aggregate, and other uses.

[4] Data may not add to totals shown because of independent rounding.

Sulfur (Recovered Elemental).—Production of elemental sulfur increased 37% to 22,532 long tons compared with 16,451 long tons in 1976. Sales rose 36% to 22,484 long tons valued at $964,769 from 16,582 long tons valued at $714,014 in 1976. Sulfur was recovered as a byproduct of petroleum-refining operations in Allen, Lucas, and Stark Counties.

Vermiculite (Exfoliated).—Crude vermiculite, mined out-of-State and shipped into Ohio, was processed by The Cleveland Gypsum Co., division of Cleveland Builders and Supply Co., at its Cleveland plant, and by O. M. Scott and Son at its Marysville plant. Production and sales increased sharply as did the value of sales in 1977. The processed vermiculite was used for concrete and plaster aggregate, insulation, and soil conditioning.

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Aluminum.—Production of primary aluminum at the Hannibal reduction plant of the Ormet Corp., jointly owned by Consolidated Aluminum Co. and Revere Copper & Brass Inc., increased sharply in both quantity and value. In 1976 there was a cutback in workers and production facilities, but by the middle of 1977 most of the workers had been rehired and the production facilities were put on line. The Hannibal plant produces aluminum by reducing alumina, which is obtained by barge from a company-owned plant at Burnside, La.

Beryllium.—Imported-beryl-ore processing was discontinued in 1977 at the Brush Wellman Inc. plant at Elmore, Ohio, and is now processed, along with domestic ore, at Brush Wellman Inc. facilities at Delta, Utah. The Elmore, Ohio, facility is the major refining-conversion plant for the processing of beryllium hydroxide from the Utah plant into beryllium metal, alloys, oxide, and other compounds. The Elmore plant also produced shapes from beryllium metal and alloys, as well as ceramics for electrical uses from beryllia.

Ferroalloys.—Ohio was the leading producer of ferroalloys, accounting for about one-third of the national total. Shipments decreased 10% to 588,500 tons compared with 656,758 tons in 1976. Value of shipments decreased 9% to $334.9 million in 1977. Six companies produced ferroalloys at eight plants in Ashtabula, Guernsey, Jefferson, Monroe, Muskingum, and Washington Counties. The ferroalloys produced consisted mainly of alloys of iron, chromium, manganese, silicon, and vanadium. Ohio Ferro-Alloys Corp. shut down the last operating furnace at Brilliant, Ohio, and in November it was decided to permanently close the plant. Their Powhatan, Ohio, plant closed down its furnaces and was put on a standby basis in November. The Philo, Ohio, plant operated at about 90% of its capacity during 1977 owing mainly to the continuing high level of operations in the automotive industry and a fairly good demand from the steel industry.

Foote Mineral Co. financed improvements in air pollution equipment in July 1977 through a $1 million Tax Exempt Air Quality Development Revenue Bond.

Iron Oxide Pigments.—Ohio's shipments of iron oxide pigments increased about 6% and the value of shipments increased 14%. Two companies produced finished iron oxide pigments in 1977. The Hilton Davis Chemical Division of Sterling Drug Inc. produced synthetic yellow iron oxide and the Ottawa Chemical Division of Ferro Corp. produced synthetic red iron oxide.

Iron and Steel.—Production of pig iron in Ohio during 1977 was 14.7 million tons, a decrease of about 1 million tons, or about 7%, from that in 1976. Shipments of pig iron totaled 14.8 million tons at a value of $2,695.2 million, compared with 1976 shipments of 15.7 million tons valued at $2,856.0 million. Ohio ranked third in the Nation in the production of pig iron. The number of blast furnaces in operation was 23 at the beginning of the year, reached a maximum of 27 during March and April, and dropped to 24 at the end of the year. Ohio has a total of 39 blast furnaces.

Steel production as reported by the American Iron and Steel Institute was 21.5 million tons, a decrease of about 1 million tons, or 4%, from 1976 production. Ohio ranked third in steel production in the Nation. The decrease in production of steel and pig iron was due in part to national strikes at coal operations, strikes at the iron ore operations in Minnesota, and a severe winter-related energy shortage in the early part of the year.

Ohio's principal pig iron and steel producers were Armco Steel Corp. in Butler County; Jones & Laughlin Steel Corp. in Cuyahoga County; Republic Steel Corp., with major plants in Mahoning, Trumbull, and Stark Counties; and United States Steel Corp. in Cuyahoga, Lorain, Mahoning, and Trumbull Counties.

At the end of 1977, the Youngstown Sheet & Tube Co. shut down its steelmaking facilities and laid off 5,000 steelworkers. Armco Steel Corp. had an 8% work force reduction resulting in the termination of 600 jobs. Smaller work force reductions were in effect at the Republic Steel Corp. plant in Cleveland and at Jones & Laughlin in Niles, Ohio. Republic Steel Corp. at its Canton, Ohio, plant installed 10 high-speed surface grinders and supporting air-pollution-control equipment. The construction of a $19,000,000 water treatment system was begun at the Canton plant. At its Cleveland basic oxygen furnace melt shop, Republic Steel Corp. completed a suppressed-combustion air-cleaning system replacement of an extensive electrostatic precipitator system.

Titanium.—The RMI Co. produced titanium sponge metal by sodium reduction of titanium tetrachloride at its Ashtabula plant. Some titanium sponge was sold on the open market and the remainder was shipped to RMI's plant in Niles, Ohio, for melting and processing. RMI Co. is the only domestic producer to sell titanium sponge on the open market.

Primary titanium metal shipped from Henderson, Nev., was rolled and fabricated at Toronto, Ohio, by Titanium Metals Corporation of America. New Jersey Zinc Co. and Glidden-Durkee Div. of SCM Corporation produced titanium pigments (titanium dioxide) at plants in Ashtabula for use in manufacturing paint. Glidden-Durkee completed expansion at its Ashtabula plant in 1977.

Zinc.—ASARCO Incorporated produced zinc oxide directly from zinc concentrates at its Columbus plant in Franklin County. Output decreased in 1977 from that of 1976. The principal uses for the zinc oxide were in the manufacture of rubber, paint, ceramics, and various chemical applications.

Zirconium.—Lincoln Electric Co., Inc. at Cleveland produced zircon-based welding rod coatings. NL Industries Inc. produced zircon refractories in Cincinnati, Hamilton County. Foote Mineral Co. processed zircon to produce zirconium alloys at its Cambridge plant, Guernsey County. Continental Mineral Process Corp. milled zirconium at Sharonville, Hamilton County, for use by iron and steel foundries and the ceramic industry. Sherwood Refractories Co., Cleveland, produced zircon cores and molds. Harshaw Chemical Co., Elyria, Lorain County, recovered zirconia for use in ceramic-based colors. Zirconium Corp. of America produced zirconia and zirconia ceramics and refractories at Solon, Cuyahoga County.

Ohio Ferro-Alloys Corp. shut down its plant at Brilliant, Ohio, during 1977.

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[1] State Liaison Officer, Bureau of Mines, Columbus, Ohio.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Columbia Cement Corp	Box 1531 Zanesville, OH 43701	Plant	Muskingum.
General Portland Cement Co.[1,2]	709 Clay St. Ft. Wayne, IN 46802	do	Paulding.
Marquette Cement Manufacturing Co.[2]	20 North Wacker Dr. Chicago, IL 60606	do	Lawrence.
Medusa Corp.[1,2,3]	Box 5668 Cleveland, OH 44101	do	Lucas.
Southwestern Portland Cement Co.[1,2]	Box 191 Fairborn, OH 45324	do	Greene.
United States Steel Corp.[1,2,4]	600 Grant St. Pittsburgh, PA 15230	do	Do.
Clays:			
Belden Brick Co	Box 910 Canton, OH 44701	Pits	Tuscarawas.
Hydraulic-Press Brick Co	Box 7786 Independence, OH 44121	do	Cuyahoga.
Kimble Coal Co	R.D. 1 Dover, DE 44622	do	Tuscarawas.
L&M Mineral Co	Star Route Millersburg, OH 44654	do	Do.
Ferroalloys:			
Foote Mineral Co	Route 100 Exton, PA 19341	Plants	Guernsey and Jefferson.
Interlake Steel Corp	13-5th & Perry Ave. Chicago, IL 60604	do	Washington.
Union Carbide Corp.[4]	Box 176 Marietta, OH 45750	do	Astabula and Washington.
Graphite, synthetic:			
OH Carbon Co	12508 Berea Rd. Cleveland, OH 44111	Plants	Cuyahoga.
Gypsum:			
Celotex Corp.[5]	1500 North Dale Malry Tampa, FL 33607	Pit	Ottawa.
National Gypsum Co.[4,5]	325 Delaware Ave. Buffalo, NY 14202	Plant	Lorain.
United States Gypsum Co.[1,4,5]	101 South Wacker Dr. Chicago, IL 60606	Underground mine.	Ottawa.
Lime:			
Huron Lime Co	Box 428 Huron, OH 44839	Plant	Erie.
Martin-Marietta Chemicals	Executive Plaza II Hunt Valley, MD 21030	do	Sandusky.
Pfizer, Inc	Box 46 Gibsonburg, OH 43431	do	Do.
Republic Steel Corp	Box 6778 Cleveland, OH 44101	do	Lake.
Woodville Lime & Chemical Corp	Box 218 Woodville, OH 43469	do	Sandusky.
Peat:			
Buckeye Peat Moss	R.D. 1 Bellefontaine, OH 43311	Bog	Logan.
Perlite, expanded:			
Cleveland Builders and Supply Co.[6]	2100 West Third St. Cleveland, OH 44113	Plant	Cuyahoga.
Petroleum refineries:			
Ashland Oil and Refining Co	1409 Winchester Ave. Ashland, KY 41101	Plants	Stark.
Gulf Oil Corp	Pittsburgh, PA 15219	do	Hamilton and Lucas.
Standard Oil Company of Ohio	Midland Bldg. Cleveland, OH 44115	Plants	Allen and Lucas.
Sun Oil Co	1608 Walnut St. Philadelphia, PA 19103	Plant	Lucas.
Salt:			
International Salt Co	Clarks Summit, PA 18411	Underground mine.	Cuyahoga.
Morton International Inc	110 North Wacker Dr. Chicago, IL 60606	do	Lake and Wayne.
PPG Industries, Inc	Box 31 Barberton, OH 44203	Plant	Summit.
Sand and gravel:			
American Aggregates Corp.[1]	Garst Ave. Greenville, OH 45331	Pits	Various.
Dravo Corp	5254 Wooster Rd. Cincinnati, OH 45226	do	Butler, Hamilton, Warren.
Tri-State Materials Corp	Box 1169 Parkersburg, WV 26101	do	Meigs.
Twin Lakes Sand Co	2307 State Rte. 303 Streetsboro, OH 44240	do	Portage.

See footnotes at end of table.

Table 11.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Carbon Limestone Co	Lowellville, OH 44436	Quarries	Mahoning.
Davon, Inc	2152 Tremont Center Columbus, OH 43221	do	Adams and Highland.
France Stone Co	1800 Toledo Trust Bldg. Toledo, OH 43604	do	Lucas, Sandusky, Seneca.
Maumee Stone Co	Box 369 Maumee, OH 43537	do	Lucas, Ottawa, Paulding, Wood.
National Lime & Stone Co.[4]	First National Bank Bldg. Findlay, OH 45840	do	Various.
Sandusky Crushed Stone Co.[4]	Box 527 Sandusky, OH 44870	Quarry	Erie.
Standard Slag Co	1200 Stambaugh Bldg. Youngstown, OH 44501	Quarries	Ottawa.

[1] Also stone.
[2] Also clays.
[3] Also sand and gravel.
[4] Also lime.
[5] Also expanded perlite.
[6] Also exfoliated vermiculite.

The Mineral Industry of Oklahoma

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Oklahoma Geological Survey under a Memorandum of Understanding for collecting information on all minerals except fuels.

By R. H. Arndt,[1] K. S. Johnson,[2] and W. E. Harrison[2]

In attaining an alltime record high value of almost $3.5 billion in 1977, the mineral industry in Oklahoma registered its 10th consecutive year of growth in total value. The increase in value from about $1.1 billion in 1969 was about 209%. Growth in value in 1977 over that of 1976 was 25.4%. Mineral fuels generated about 95% of the State's total mineral value, and the remainder was in nonfuel minerals. The value of mineral fuels in 1977 was at least 25% higher than in 1976, and that of nonfuels was about 28% higher. Reported output of clays, crude helium, liquefied petroleum (LP) gases, crude petroleum, tripoli, zinc, and lime were less in 1977 than in 1976. Output of other mineral commodities increased. Values of tripoli, zinc, and lime decreased in 1977. Oklahoma's rank in the value of mineral production among the United States was 4th. It ranked first in the production of iodine, second in the production of helium and tripoli, third as a source of natural gas, and fourth in natural gas liquids. Income to the State for the fiscal year ending June 30, 1977, in the form of gross production and excise taxes on produced oil and gas, was $193 million. No other produced mineral was subject to the gross production tax.

Table 1.—Mineral production in Oklahoma[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---- thousand short tons	1,155	$1,678	1,016	$1,687
Coal (bituminous) ---- do	3,635	58,102	5,978	105,433
Gypsum ---- do	1,120	5,822	1,238	6,959
Helium:				
High purity ---- million cubic feet	^{r}241	^{r}7,610	389	11,507
Crude ---- do	^{r}183	^{r}2,200	W	W
Natural gas ---- do	1,726,513	866,710	1,769,519	1,397,920
Natural gas liquids:				
Natural gasoline and cycle products ---- thousand 42-gallon barrels	10,894	74,416	41,893	271,214
LP gases ---- do	31,620	179,602		
Petroleum (crude) ---- do	161,426	1,484,297	156,382	1,560,240
Pumice ---- thousand short tons	1	W	1	W
Sand and gravel ---- do	10,037	19,050	11,669	26,827
Stone ---- do	19,635	37,339	23,332	47,443

See footnotes at end of table.

Table 1.—Mineral production in Oklahoma[1] —Continued

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Combined value of cement (masonry and portland), feldspar (feldspathic sand), iodine (1977), lead, lime, salt, tripoli, zinc, and items indicated by symbol W	XX	53,100	XX	68,217
Total	XX	2,789,926	XX	3,497,447
Total 1967 constant dollars	XX	1,002,978	XX	ᵖ1,726,340

ᵖPreliminary. ʳRevised. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Oklahoma, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adair	$31	$21	Sand and gravel.
Alfalfa	31,231	--	
Atoka	W	W	Stone, sand and gravel.
Beaver	88,705	W	Sand and gravel, pumice.
Beckham	11,049	--	
Blaine	83,078	W	Gypsum, sand and gravel.
Bryan	4,778	W	Stone, sand and gravel.
Caddo	120,384	W	Gypsum, sand and gravel.
Canadian	90,610	W	Sand and gravel, clays, gypsum.
Carter	200,981	66	Stone.
Cherokee	W	W	Do.
Choctaw	W	W	Stone, sand and gravel.
Cimarron	21,922	W	Helium.
Cleveland	18,220	476	Sand and gravel.
Coal	4,865	W	Stone.
Comanche	6,615	W	Stone, gypsum.
Cotton	6,693	775	Sand and gravel.
Craig	24,362	523	Stone.
Creek	67,882	W	Stone, clays, sand and gravel.
Custer	18,020	W	Clays, sand and gravel.
Delaware	W	--	
Dewey	92,102	--	
Ellis	28,351	--	
Garfield	76,560	W	Sand and gravel.
Garvin	107,878	W	Do.
Grady	165,954	--	
Grant	12,356	--	
Greer	1,187	W	Stone, clays, sand and gravel.
Harmon	W	W	Salt.
Harper	44,013	--	
Haskell	W	--	
Hughes	11,489	--	
Jackson	3,847	W	Gypsum, sand and gravel.
Jefferson	5,063	--	
Johnston	6,589	W	Sand and gravel, stone.
Kay	37,534	W	Stone, sand and gravel.
Kingfisher	133,779	W	Sand and gravel.
Kiowa	3,350	W	Stone.
Latimer	16,211	W	Sand and gravel.
Le Flore	W	W	Sand and gravel, clays.
Lincoln	21,508	--	
Logan	25,944	W	Sand and gravel.
Love	10,981	--	
McClain	39,759	725	Sand and gravel.
McCurtain	W	W	Sand and gravel, stone.
McIntosh	W	W	Stone.
Major	95,657	--	
Marshall	9,973	--	
Mayes	15,201	19,567	Cement, stone, clays, sand and gravel.
Murray	18,160	W	Stone.
Muskogee	6,828	W	Sand and gravel, feldspar.
Noble	23,167	--	
Nowata	6,103	W	Stone.
Okfuskee	9,545	--	
Oklahoma	57,481	3,509	Sand and gravel, clays.

See footnotes at end of table.

Table 2.—Value of mineral production in Oklahoma, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Okmulgee	$14,950	W	Stone.
Osage	128,187	W	Do.
Ottawa	1,098	W	Stone, sand and gravel, tripoli, zinc, lead.
Pawnee	12,361	W	Stone, sand and gravel.
Payne	24,042	$566	Sand and gravel.
Pittsburg	19,397	W	Stone, sand and gravel.
Pontotoc	72,154	26,402	Cement, stone, sand and gravel, clays.
Pottawatomie	23,333	W	Sand and gravel.
Pushmataha	1	W	Do.
Roger Mills	16,917	--	
Rogers	26,770	W	Cement, stone, clays.
Seminole	54,902	W	Stone, sand and gravel, clays.
Sequoyah	5,628	W	Lime, stone, sand and gravel.
Stephens	226,092	--	
Texas	132,976	W	Sand and gravel.
Tillman	W	350	Do.
Tulsa	20,273	W	Stone, sand and gravel, clays.
Wagoner	2,054	355	Sand and gravel.
Washington	W	W	Stone.
Washita	2,195	--	
Woods	25,677	W	Sand and gravel, salt.
Woodward	42,343	W	Iodine, sand and gravel.
Undistributed[2]	52,584	3,444,113	
Total[3]	2,789,926	3,497,447	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Petroleum is based on an average price per barrel for the State and natural gas is based on an average price per cubic foot for the State.

[2] Includes some sand and gravel, coal, petroleum, natural gas and natural gas liquids that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Legislation and Government Programs.—Legislative discussion and action in the First Session of the 36th Oklahoma Legislature relating to mineral issues dealt mostly with oil and gas, energy, rate structure, and the functioning of public utilities as related to the rapidly increasing costs of fuels. The Legislature passed a measure that defined the maximum allowable spacing of oil and gas wells in a drilling unit to be 640 acres plus 20% for tolerance. The measure overrode a previous ruling by the Oklahoma Corporation Commission (OCC) that had established a maximum spacing as 1,440 acres. House Bill 1441 provided modifications to the gross production tax on oil and gas produced for interstate markets to make it equal unit for unit with that paid on produced intrastate oil and gas. The bill levied a conservation tax of 7 cents per thousand cubic of produced gas, less 7% of the gross value of each such 1,000 cubic feet of natural gas or casinghead gas. The Legislature focused attention on the right to use Oklahoma energy materials and on the protection of the public from excessive costs for the use of energy. Farmers were granted the right to use gas produced on their property or transported in pipelines crossing their property as fuel for pumping subsurface water for irrigation, by Senate Bill 160. Senate Bill 273 assigned controls over fuel cost adjustments to the OCC and provided for public inspection of all proceedings dealing with their administration. Senate Bill 374 prohibited the inclusion of advertising expenses by a public utility in its rate making, and Senate Bill 375 prohibited the payment of other promotional incentives as part of the operating expenses by utilities. Concern for conservation of energy was expressed through House Joint Resolution 1013 which urged the State Department of Energy to study alternative and supplemental energy sources for possible use by the State boards and agencies. House Bill 1322 provided a tax credit of not more than 25% of the cost of installing a solar energy device in a taxpayer's residence, the credit not to exceed $2,000. Eminent domain was granted for the construction of interstate pipelines for the transportation of coal to Oklahoma from other States by Senate Bill 119. Firms so doing would be licensed under the OCC. The bill prohibited the use of water from Oklahoma in such pipelines, and required that the Corporation Commission act under the recommendation of the Oklahoma Water Resources Board on the disposal of water withdrawn from the pipeline. Scenic River Commissions were established by Senate Bill 285 to provide coordination and cooperation between State and local governments in the preservation of scenic qualities of rivers. The legislation involves potential conflict with mining and mineral industries that are located in stream valleys, particularly in the right to extract sand and gravel from deposits in streambeds or to use river waters for mineral processing. The State Senate affirmed Oklahoma's priority over a portion of the unused and uncontrolled waters flowing from the State in Senate Joint Resolution 70. A general objective would be to assure sufficient water at proper localities for the support of future domestic, municipal, agricultural, and industrial activities in the State through a statewide comprehensive water plan. As part of its responsibilities that resulted from the Legislature's intent that cost of energy to consumers be kept to a minimum, the OCC heard requests for increased rates submitted by Oklahoma Natural Gas Co. (ONG), Public Service Co. of Oklahoma (PSO), and Oklahoma Gas and Electric Co. (OG&E). The hearings and discussions involved the disposal of windfall profits enjoyed by ONG during emergency winter sales of natural gas to interstate companies. The establishment of lifeline rates for consumers of low volumes of natural gas to prevent increase of rates and to provide rebates from off-system sales profits was also debated.

The Oklahoma Geological Survey pursued investigations in mineral resources. In cooperation with the U.S. Geological Survey, it was engaged in an inventory of surface-mined lands exclusive of coal lands and in studies of the State's water resources. Accumulation of data on the Hartshorne coal and for coal analysis was continued, in part cooperative with the Federal Bureau of Mines. Continuing cooperative programs with the Bureau of Mines were for testing clay and for the accumulation of mineral statistics for the Minerals Yearbook. Heavy oil and tar sands in the Oklahoma part of the Tri-State area and a geological appraisal of uranium resources in several areas in north-central and central-western Oklahoma were supported by the U.S. Department of Energy. Other energy programs included sampling and testing water under the Natural Uranium Resource Evaluation Program, and an investigation of the seismicity of the Nemaha uplift for the Nuclear Regulatory Commission. The Oklahoma Geological Survey's services to the State included assistance to the Department of Economic and Community Affairs in planning for underground disposal of waste. Geologic mapping was in various stages of completion in eight different quadrangles. Occurrence of asbestiform minerals in limestone and dolomite, occurrence of base metals in the Arbuckle Mountains, and various stratigraphic and paleontological problems were also being investigated by the Oklahoma Geological Survey. Among the Geological Survey's publications in 1977 was a map of eastern Oklahoma showing active coal mines (January 1, 1977) by S. A. Friedman. K. S. Johnson and R. L. Croy edited a Symposium: Stratiform Copper Deposits of the Midcontinent Region, which was published as Oklahoma Geological Survey Circular 77, 1976. The Survey also published posthumously Geology and Mineral Resources (Exclusive of Petroleum) of Muskogee County, Oklahoma, by M. C. Oakes as Oklahoma Geological Survey Bulletin 122, 1977.

The Oklahoma Department of Mines continued its efforts to establish a miner training institute under the academic umbrella of Southeastern Oklahoma State University, aided by a grant from the U.S. Mining Enforcement and Safety Administration. The department was also engaged in efforts to strengthen the State's coal mining and reclamation laws and extend the reclamation to abandoned surface-mined coal lands.

The Oil and Gas Conservation Division of the Oklahoma Corporation investigated pollution compliants, inspected drilling and producing oil operations, provided consultations, and made water analyses in the process of curtailing pollution problems. The division also plugged a number of purging abandoned oil wells for which individual responsibility could not be ascertained.

Formulation and implementation of a statewide energy conservation plan was the chief thrust of the State Department of Energy. Through district meetings, Oklahoma Conservation Commission undertook the first steps in rallying conservation districts to the ultimate development and application of plans to reclaim abandoned surface-mined coal lands. Social and economic impacts of surface mining coal and subsequently reclaiming the mined land were being studied by the Department of

Agricultural Economics at Oklahoma State University and the Oklahoma State University State Extension Service. Among their objectives was to assist residents on coal lands to adjust their existence to the changes created by mining and reclamation.

Numerous research contracts were let to researchers in Oklahoma by the Federal Bureau of Mines. Some of the researches were applied in the State, some were applied in other areas. Continental Oil Co. at Ponca City was involved with the development of a technique for controlling methane in gob areas in coal mines. Research and development of large diameter drilling equipment by Fenix & Scisson, Inc., Tulsa, Okla., was a project related to advanced mining technique and high speed mine development. McCarthy Engineering & Construction, Inc., Tulsa, Okla., was field testing chemical injection for stabilizing coal mine roofs, a ground control technique. Kerr-McGee Nuclear Corp., Oklahoma City, held a contract for studying radiation hazards and their control through mine ventilation. Data accumulation on Hartshorne coalbeds in Haskell and Le Flore Counties were made by the Oklahoma Geological Survey as part of the advanced mining technology and methane recovery programs of the Bureau. U.S. Energy Research and Development Administration Bartlesville Energy Research Center studied reduction of air pollutants from engines operated underground, an industrial hygiene project. Fenix & Scisson, Inc., in Tulsa, were also involved in a conceptual design of automated longwall mining systems, a study of underground rubblization and in situ retorting systems for deep oil shale deposits. The Bureau also operated a helium refinery at Keyes and maintained a liaison office in Oklahoma City.

The Conservation Division of the U.S. Geological Survey (USGS) maintained offices in Tulsa and Oklahoma City for surveillance of oil and gas operations on Federal and Indian lands, an office in Tulsa to perform similar functions on Federal and Indian mining leases, and a geological office in Tulsa for evaluation and classification of mineral resources on Federal and Indian lands as well as providing geological consultation for the Conservation Division and other Federal offices. An office of the Water Resources Division, USGS, in Oklahoma City, collected data on streamflow, subsurface water supplies, tested water quality, and engaged in cooperative studies with the Oklahoma Geological Survey, the U.S. Bureau of Reclamation, and the Oklahoma Water Resources Board. The Water Resources Division also provided base data about quality and volume of surface and subsurface water for a U.S. Bureau of Land Management regional study of federally controlled coal resources. In cooperation with the Oklahoma Geological Survey and the Northeast Counties of Oklahoma Economic Development Association (NECO), the Water Resources Division monitored rising waters in the abandoned zinc mines in Ottawa County. S. J. Playton and R. E. Davis prepared a Preliminary Report on the Quality of Water in Abandoned Zinc Mines in Northeastern Oklahoma as Open File Report 77-7163 of the U.S. Geological Survey.

A task force of the U.S. Bureau of Land Management was studying the potential environmental, social, and economic impact and problems associated with the future leasing and mining of federally held coal in eastern Oklahoma.

Wide ranging studies and projects related to the enhanced recovery of oil and gas were pursued or administered at the Bartlesville Energy Research Center, U.S. Energy Research and Development Administration—U.S. Department of Energy (DOE). The Center was also concerned with advance research and supporting technology, such as testing of synthetic fuels for automobiles, the characterization of syncrudes from coal, and thermodynamic studies on coal conversion processes. Petroleum product characterization and utilization were also under study. Waste oil recycling, automotive powerplant technology assessment, and alternate transportation fuels studies related to energy conservation. At the same time, the Energy Research Center continued fully funded research for the Bureau of Mines, the Air Force, Department of Transportation, and other federal agencies.

Table 3.—Indicators of Oklahoma business activity

	1976	1977[p]	Change percent
Employment and labor force, annual average:			
Total civilian labor force ---- thousands	1,160.0	1,223.0	+5.4
Unemployment ---- do	65.0	61.0	-6.2
Employment (nonagricultural):			
Mining ---- do	44.4	48.9	+10.1
Manufacturing ---- do	156.1	162.8	+4.3
Contract construction ---- do	46.1	49.4	+7.2
Transportation and public utilities ---- do	57.3	59.2	+3.3
Wholesale and retail trade ---- do	222.2	231.9	+4.4
Finance, insurance, real estate ---- do	46.6	48.9	+4.9
Services ---- do	151.4	159.4	+5.3
Government ---- do	207.0	214.5	+3.6
Total nonagricultural employment ---- do	931.1	975.0	+4.7
Personal income:			
Total ---- millions	$15,809	$17,839	+12.8
Per capita	$5,707	$6,346	+11.2
Construction activity:			
Number of private and public residential units authorized	15,805	21,256	+34.5
Value of nonresidential construction ---- millions	$282.1	$414.5	+46.9
Value of State road contract awards ---- do	$84.7	$85.0	+.4
Shipments of portland and masonry cement to and within the State thousand short tons	1,323	1,665	+25.8
Mineral production value:			
Total crude mineral value ---- millions	$2,789.9	$3,497.4	+25.4
Value per capita, resident population	$1,009	$1,244	+23.3
Value per square mile	$39,902	$50,021	+25.4

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Employment and Wages.—Oil and gas mining and other mining are the two categories utilized by the Oklahoma Employment and Security Commission (OESC) in reporting statistics of the mineral extraction industries. Average monthly employment in the mining industries was 50,000 in 1977, about 20% higher than in 1976. Of these, about 47,900 workers were employed in the extraction of oil and gas, and 2,000 mined other substances. Demand for oilfield workers to support the highest rate of oil well drilling since the 1950's caused the number of oilfield workers to rise by about 2,500 during 1977 to a total of 47,900. Contrastingly, the total number of workers employed in hardrock mining remained relatively constant at 2,100 to 2,300. Oklahoma Department of Mines reported separately that 3,185 persons were employed in mining of nonfuel minerals and coal in 1977. Monthly average employment in the petroleum refining industry in 1977 was 7,067, about 391 less than the average monthly number employed in 1976. Wages and salaries paid to oilfield and gasfield workers in 1977 were about $715.9 million. Refinery workers had total earnings of $118.6 million, with a weekly average per worker of $322.82. This was the highest individual average weekly earning recorded among 20 manufacturing and nonmanufacturing categories monitored by OESC. An average weekly earning of $285.28 for oilfield and gasfield workers ranked second among the same categories. Three types of manufacturing industries are closely alined with the extraction of minerals. These are petroleum and coal products of the Standard Industrial Classification (SIC) 29, most of which in Oklahoma are products of petroleum refining. Others are Stone, Clay, and Glass Products (SIC 32), and the Primary Metals Industry (SIC 33). In 1977, stone, clay, and glass industries had 10,600 employees with total earnings of $128.1 million. Primary metals industries employed 5,292 with total earnings of $66.1 million. Thus, OESC reported the mining industries and the immediately related manufacturing industries employed about 72,959 people in 1977. Total earnings of this group, exclusive of those engaged in hardrock mining for which the statistics are not available, amounted to $1,027.9 million, and employment was about 7.5% of the State's employed labor force.

Transportation.—The bulk of mineral materials are transported by highway, railway, and pipeline in Oklahoma; however, in the vicinity of the McClellan-Kerr-Arkansas River Navigation System, which utilizes the Arkansas River and heads at the Tulsa Port of Catoosa in Rogers County, some of the mineral commodities shipped in bulk are advantageously transported by barge on the river system. According to the monthly reports of navigation made by the Tulsa District Corps of Engineers, that section of the navigation system within Oklahoma carried 932,468 tons of petroleum products in 1977, an increase of 40% above that of the previous year. Transported coal increased 129% above 1976 cargo to 438,315 tons in 1977, accompanying attainment of an alltime record production of coal in 1 year. The 203,057 tons of stone carried in 1977 was 95% above that carried in 1976. Transported sand and gravel amounted to 169,000 tons in 1977, 36% above such cargo in the previous year. Petroleum products were carried both outbound and inbound, whereas coal was largely outbound. Sand and gravel and stone moved internally within the State, partly in response to the needs of the Corps of Engineers for the construction materials, partly as sand and gravel dredged from the river and transported to a land base. The four mineral substances made a total cargo of 1,742,840 tons, which was 63% of all of the material carried in the Oklahoma part of the Arkansas River Navigation System in 1977. This was a new mineral cargo record for quantity transported in 1 year. Shipments of chemical fertilizer, a manufactured product of the mineral industry, increased from 63,252 tons in 1976 to 135,191 tons in 1977. With the addition of iron and steel, metal products, and other chemicals transported on the waterway, to those of the foregoing mineral materials, the total of waterborne raw mineral materials and manufactured mineral products was 2.2 million tons in 1977. This was 80% of all the cargo carried in the Oklahoma segment of the waterway.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels maintained their customary dominance of mineral output in Oklahoma in 1977 by generating a value of at least $3.3 billion, which was 95% of the State's total mineral value.

Gross production tax on crude oil and natural gas, and the petroleum excise tax provided $193.6 million to the State in fiscal year 1977. This was about 17% of the State's total tax collections that year. Estimated State income from gross production tax, royalties from oil and gas produced on State school lands, and lease bonuses were $225 million in calendar year 1977. Estimated lease bonus payments and royalties to Indians were $35.4 million, of which about $21.3 million went to the Osage Tribal Council, in calendar year 1977. The Federal Government received about $6.8 million on oil and gas royalties and lease bonuses.

Carbon Black.—Continental Carbon Co., the State's only producer of carbon black, continued operating its plant at Ponca City. Liquid hydrocarbons were the materials processed.

Coal.—Coal production reached a record output in 1977 of 6.0 million short tons, which exceeded output in 1976 by about 64%. The record was achieved by 46 surface mines controlled by 40 companies. Mines were situated in 11 counties of eastern Oklahoma. Oklahoma Department of Mines records show that Craig County led all others with recovery of 2.5 million tons of coal from nine mines. All coal was mined by surface methods.

Helium.—Extraction of helium from natural gas continued at the Federal Bureau of Mines Helium Plant near Keyes. Total value of produced helium was higher in 1977 than in 1976, based on a 61% increase in the volume of high-purity helium produced. Output and value of crude helium declined. Helium produced at Keyes was either stored or sold to government agencies for use in government projects.

Natural Gas.—By attaining output of almost 1.8 trillion cubic feet of natural gas, State output in 1977 rose 2.5% above output in 1976. A value of $1.4 billion for produced natural gas was 61.3% higher than in 1976. Texas, Dewey, Beaver, Grady, and Harper Counties led all others in recovery of natural gas.

Natural Gas Liquids.—State output of natural gas liquids, reported at almost 41.9 million barrels in 1977, was 621,000 barrels, or 1.5%, less than in 1976. Value reported was $271.2 million in 1977, about 6.8% higher than in the previous year.

Petroleum.—State wells yielded 156.4 million barrels of crude petroleum in 1977 valued at $1,560 million for a unit value of almost $10 per barrel. Production of crude petroleum in 1977 was reduced 3.1% from that of 1976, but the value of output increased 5.1%. Records of the Oklahoma Tax Commission indicate that crude oil was produced in 66 counties, and Stephens, Carter, Osage, Garvin, and Grady Counties were the leading sources of crude petroleum.

NONMETALS

Cement.—The cement industry returned essentially to full production in 1977 as conversion of kilns from gas-fired to coal-fired kilns was completed. Consequently, production increased by 16% and value by 25% in 1977 as contrasted with those of 1976. About 96% of the product was portland cement, including both white and gray varieties, adjusted for general-purpose-moderate-heat, high-early-strength, very high-sulfate-resistance, oilwell, and waterproof use requirements. The remainder was masonry cement. Ideal Basic Industries Ideal Cement Co. at Ada, Martin Marietta Co. at Tulsa, and OKC Corp. Oklahoma Cement Co. at Pryor, each operated two kilns. Ideal's kilns were wet process and the others were dry process. Martin Marietta and OKC Corp. plants had glass baghouse pollution controls, and Ideal used electric precipitators. The three plants consumed 2.4 million tons of limestone; 336,100 tons of clay, shale, and bauxite; 6,007 tons of sand; 11,100 tons of iron ore; and 73,600 tons of gypsum. Operations required approximately 3 billion cubic feet of natural gas, about 50% less than in 1976. Bituminous coal consumption was 164,000 tons, about 290% more than in the previous year. Purchased electric energy increased 10.3% to 216.6 million kilowatt-hours. About 61% of the cement sold or used went into the ready-mix industry; 10% went as building materials; 9% was purchased by concrete products manufacturers; highway contractors also purchased 9%; other contractors, 8%; government agencies purchased less than 0.1%; and miscellaneous customers, about 2%. Almost 90% of the material delivered to customers was shipped in trucks, 9.3% by rail, and about 1% by barge.

Clay and Shale.—Clay producers reported mining 1 million tons of clay valued at $1.7 million in 1977, for an apparent reduction of 12% in quantity and an increase of 0.5% over that of the previous year. In actuality, the apparent reduction of output was caused largely by a change in accounting procedures by one of the major producers, with other changes recorded for producers nearly offsetting each other. Pontotoc, Oklahoma, and Canadian Counties collectively accounted for 58% of the clay and shale mined, and 61% of the total clay value. Clay was also mined in Rogers, Tulsa, Mayes, Seminole, Custer, Le Flore, Greer, and Creek Counties. Chandler Materials Co., Ideal Basic Industries Ideal Cement Co., and Justin Industries Acme Brick Co., operating a total of six mines, produced more than half of the State's clay and shale tonnage. Nine other firms each operated one mine. All mining was performed as the first function in a manufacturing industry operated by the responsible company. Six firms used about 43% of the clay produced in the manufacture of face brick. The remainder of the clay and shale was used in three cement plants, in the manufacture of lightweight aggregate for concrete block and structural concrete, and in sewer pipe and pottery. Manufactured products were marketed largely within the State and in adjacent portions of bordering states. One firm indicated a national market for its brick.

Acme Brick Co. was able to reduce the amount of fuel required some 15% to 20% per unit of brick produced by the application of new technology in the Tulsa, Clinton, and Edmond plants. At the same time they increased output of brick by 25%. By reinsulating its kilns and using waste heat from the kiln in the dryer, Mangum Brick Co. was able to reduce energy consumed by almost 60%, coincidental with an increase in production. Construction of a new brick plant in Oklahoma City was undertaken by Acme Brick Co. in the fall of 1977. Planned capacity of this plant is 50 million brick per year.

Commercial Brick Co. reported that heavy demand for brick created a lag of 20 to 22 weeks between order and delivery. Price for brick had risen from about $96 per thousand in late 1976 to $130 per thousand in September 1977. Economic Development Administration granted the Cherokee Nation of Oklahoma $1 million in September for construction of a pottery plant at Tahlequah.

Feldspar.—Increases in both output and value of feldspar in 1977 over those recorded in 1976 amounted to 1% and 10% respectively. This feldspar comprises about 25% of a feldspar-silica mixture recovered from sands of the Arkansas River by Arkhola Sand & Gravel Co. at Muskogee in Muskogee County. The mixture was sold to glass manufacturers primarily for its feldspar content.

Gypsum.—With production of 1.2 million tons of gypsum in 1977, valued at about $7 million, Oklahoma maintained its sixth place among gypsum-producing States. Production was 10.6% above that of 1976, whereas value increased by almost 20%. Blaine and Jackson Counties provided 72% of the gypsum produced and generated 71% of the value. Gypsum was also mined in Caddo, Canadian, and Comanche Counties. All gypsum was mined from strata in the widespread formations of the Permian system including the Blaine Formation in Blaine, Canadian, and Jackson Counties; and the Cloud Chief Formation in Caddo and Comanche Counties. United States Gypsum Co. and Republic Gypsum Co. retained their status as the leading producers. Temple Gypsum (division of Temple Eastex, Inc.) displaced United States Steel Corp. Universal Atlas Cement division as third largest producer. The three leaders provided about 77% of 1977 gypsum output and 78% of its value. Calcined gypsum, for use in the manufacture of plasters, gypsum board, and specialty products, was the principal product of the United States Gypsum Co. and Republic Gypsum Co. From Temple Gypsum mine in Comanche County gypsum was shipped to West Memphis, Ark., for calcining and the manufacture of gypsum board. Universal Atlas Cement Co. led production of raw gypsum for retarder in cement manufacture. Raw gypsum was also used as a filler and soil conditioner.

Though most of the companies reported heavy demand for their product, no new mine was opened, nor were operations appreciably modified by changes in equipment or technology. According to the Oklahoma Department of Mines, 72 men were employed in mining gypsum. These miners were employed an average number of 236 working days. No fatalities were registered and only four compensable nonfatal accidents occurred.

Iodine.—January 1977 brought a change from the construction stage to a testing stage for the Woodward Iodine Operations of the Houston Chemical Co. and AMOCO Production Co. The first extraction of iodine from formation brines took place in testing during February. By May, commercial production of iodine was underway. Brine is obtained from subsurface formations through nine wells. These brines are gathered and pumped to the plant where iodine is air stripped, collected, and the residual brines are returned to the subsurface in five injection wells. Natural gas produced with the brine amounts to several million cubic feet a day, which is sufficient for collection and delivery to a natural gas pipeline. Total production is expected to be in the realm of 2 million pounds of iodine a year. The firm was engaged in litigation with neighboring landowners who claimed that reinjection of the spent brines into the subsurface forced out mineral values from their own subsurface holdings. In addition, the ownership of the natural gas was to be decided by court action. The applications of iodine are largely chemical. Indicated uses of the iodine are as industrial catalyst, feed supplement for animals, and in the manufacture of synthetic rubber, nylon, inks, dyes, and pharmaceuticals. One of the iodine compounds aids in the X-ray studies of human organs.

Lime.—A 3 months' strike at St. Clair Lime Co. by workers in the last half of 1977 reduced total lime output by about 21% and value by almost 11% from the 1976 performance. Conversely, shipments to Oklahoma of lime sold or used by producers increased 35% to 104,268 short tons for quicklime, and 81% to 42,252 short tons for hydrated lime. Despite installation of dust control equipment in 1976, residents of Marble City living in the vicinity of the plant brought suit against the company, seeking redress for damage to homes, automobiles, lawns, and gardens caused by blowing lime dust. The St. Clair lime was prepared from limestone quarried underground from the Quarry Mountain Formation of Silurian age. It was utilized to stabilize soil, control acidity in agricultural soils, and in preparation of chemicals. St. Clair Lime Co. also sold crushed limestone for manufacturing glass.

Pumiceous Material (Volcanic Ash).—Axtell Mining Corp. at Gate in Beaver County, producers of volcanic ash, reported increases of 34% in the quantity and 52% in the value of their product in 1977 above output and value in 1976. Axtell indicated use of the product for soft abrasives and other unspecified purposes. The Oklahoma Geological Survey found that the source ash beds contain more than 97% of shards of volcanic glass mixed with some feldspar, clay, quartz, mica, and diatom fossils. The assemblage suggests that the beds collected as windblown dust in lakes during the Pleistocene.

Salt.—Two firms recovered salt brine and crystal salt from salt springs and wells in Harmon and Woods Counties. Total production of brine in 1977 increased 67% over that in 1976, and the value increased 169%. Produced stable brines made up 87% of the increase in the State's total salt output. The industry is small, with output ranking among that of producing states, although resources are very large.

Salt in near-surface layers interbedded with shale in the Blaine Formation of Permian age is dissolved by ground water. Resulting brines that accumulate in solution cavities eventually reach the surface as springs or are pumped to the surface through shallow wells drilled into the cavities. Recovered brine is sold either as stable brine for oil well drilling or is run into broad surface pans for the precipitation of crystal salt by solar evaporation. Analyses by the State Geological Survey indicate that recovered salt contains about 98% NaCl, 1.8% gypsum, and has a small quantity of quartz that probably accumulated as dust in the evaporating pans. The crystallized salt is sold as a road deicer, as a recharger for zeolite-charged water softeners, and as stock feed.

Sand and Gravel.—Following the general trend in most construction materials, the 11.7 million tons of sand and gravel used or sold by producers in 1977 was 16% greater than in 1976, and value increased by 41% to $26.8 million. Mining occurred in 42 counties with production from 111 plants. Tulsa County led all others with production of 2.8 million tons, followed by Oklahoma, Johnston, and Muskogee Counties. Together their output was about 55% of the sand and gravel produced in the State and provided 60% of the value. Although there were more than 100 producers, 52% of the sand and gravel was supplied by 11 firms. Sand and gravel sold or used for construction, comprising about 87% of the total output, had an increase in value of 54% over the value in 1976. Average unit value of construction sand and gravel was $1.80 per ton.

The production of fine-grained aggregate for concrete, asphaltic concrete, and fill in 1977 ranged from 20% to 24% above that of 1976. Road bases and coverings had a slight increase in output. Sand and gravel produced for concrete products and other use decreased by 37% and 83%, respectively, in 1977.

Output of industrial sand and gravel in 1977 surpassed that of 1976 by 11% with a correlative 18% increase in value. Average unit value was $5.91 within a range of $2.73 to $19.85 per ton. Arkhola Sand and Gravel Co., J & B Construction Co., Midcontinent Glass Sand Co., and Pennsylvania Glass Sand Corp. produced 1.4 million tons of industrial sand valued at $8.4 million. More than half of the sand was used in manufacturing glass. Unground sand was also used for foundry molding, sand blasting, engine sand, and Hydrafrac processes applied in oil and gas recovery. Ground sand was used for filler, enamel, abrasives, pottery, porcelain, and tile.

Industrial sand had nationwide markets. Construction sand and gravel had essentially local or State markets; consequently, industrial sand was transported largely by rail and construction sand and gravel was transported mostly by trucks.

Sand and gravel is generally mined as close to its market as possible because of the commonly low unit value and wherever a deposit of sufficient size and quality is conveniently available. Thus, Tulsa and Oklahoma Counties, which include the State's two most populous cities, supported the largest sand and gravel industries. There and also in Muskogee, sand and gravel was recovered from alluvium in streambeds and flood plains. Other deposits are in residual upland terraces. Glass sand of high purity is recovered from the McLish and Oil Creek Formations of the Ordovician System in Pontotoc and Johnston Counties. Gravel-laden deposits are found in strata of Cretaceous age in south-central and southeastern Oklahoma, and in surface deposits of Tertiary age in western Oklahoma.

Table 4.—Oklahoma: Sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	7,435	9,101	7,892	13,890
Gravel	1,326	2,874	2,362	4,575
Total[1]	8,760	11,975	10,255	18,465
Industrial:				
Sand	1,277	7,075	1,414	8,362
Gravel	--	--	--	--
Total	1,277	7,075	1,414	8,362
Grand total	10,037	19,050	11,669	26,827

[1] Data may not add to totals shown because of independent rounding.

Table 5.—Oklahoma: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	3,957	6,356	4,921	10,499
Concrete products	984	1,841	623	1,255
Asphaltic concrete aggregates	374	784	1,128	2,257
Roadbase and coverings	1,072	1,103	1,077	1,779
Fill	2,007	1,660	2,444	2,508
Railroad ballast	W	W	W	W
Other uses	367	231	61	167
Total[1] or average	8,760	11,975	10,255	18,465

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Data may not add to total shown because of independent rounding.

Stone.—Output of 23.3 million tons of stone valued at $47.4 million in 1977, establishing a new record production and value, reversed a steady decrease in production of stone during the three previous years. Limestone, sandstone, granite, and dolomite were quarried, and chat was shipped from residual piles of waste from the zinc mining industry in Ottawa County. More than 99% of the quarried stone was crushed and used principally in concrete aggregate, dense-graded roadbase stone, and cement manufacture, as enumerated in table 7. Production of crushed stone for concrete aggregate, surface treatment aggregate, and railroad ballast, each increased by more than 36% over that in 1976. Output of crushed stone as riprap and jettystone decreased by almost 39%. Other changes in production for specific use categories were of a minor nature. Produced dimension stone included irregularly shaped blocks of limestone, rough blocks, monumental stone, and construction stone of granite.

Tulsa County in the northeast, Murray County in the Arbuckles, and Comanche County in the Wichita Mountains area, led in order all other counties in stone production. Tulsa and seven bordering counties yielded 31% of the State's total stone production and 28% of the value. Nine counties in the Wichita and Arbuckle Mountains collectively accounted for 41% of State stone production and 42% of the value. Limestone was quarried in the Tulsa area. Limestone and granite were obtained from the vicinity of the Wichita Mountains. Limestone, granite, and dolomite were produced in the Arbuckle Mountains. Sandstone was quarried near Checotah in McIntosh County and Apple in Choctaw County, by H. D. Youngman, Contractor. Forty-three firms quarried stone, utilizing 64 quarries. Dolese Bros. Co., Ashland Oil, Inc., Standard Industries, Inc., Anchor Stone Co., Tulsa Rock Co., and Ideal Basic Industries

Ideal Cement Co., collectively produced 65% of the State's total stone. Fifty-two percent of the State's product was derived from eight quarries, with individual production exceeding 900,000 tons. Output in the range of 500,000 to 899,999 tons, accounting for an additional 24% of the State's output, was obtained from 8 quarries. Less than 1% of the State's output came from 18 quarries where individual production was less than 25,000 tons. Trucks transported 20.6 million tons of stone from quarries to markets. About 1.8 million tons of stone was carried by railroads. Less than a million tons of stone was reported by producers to be carried by other or unidentified means. Stone shipped by barge on the McClellan-Kerr-Arkansas River Navigation System was credited to internal operations by the Corps of Engineers.

Granite is the chief dimension stone quarried in Oklahoma. Century Granite Co. prepared rough blocks and monumental stone from quarries in Greer and Johnston Counties. Willis Granite Co. quarried and prepared rough monumental blocks and dressed monumental stone in Greer County. Fairfax Granite Co. and Wichita Granite Co. produced monumental stone, and Roosevelt Granite Co. produced construction stone from granite in Kiowa County. Rough monumental stone was the product of Bodie L. Anderson Quarries, Inc. in Johnston County. Pontotoc Stone Co. was the only reported source of irregularly shaped construction limestone in the State.

The 19% increase in quantity produced and 27% increase in value between 1976 and 1977 reflect acceleration in the construction industries. Total contract awards in 1977 for all construction in the State were about $2.5 billion, representing an increase of about 71% over total contract awards in 1976. More than half of this was in nonresidential and nonbuilding contract awards. Maximum gains were experienced in industrial contracts (204%), and in nonbuilding contracts other than streets and highways (203%), according to the Center for Economic and Management Research in the College of Business Administration at the University of Oklahoma.

Emergence of environmental issues affected the operations of several of the stone producers. After 5 years of litigation in the courts, Tulsa Rock Co. won the right to operate its new limestone quarry near Owasso, north of Tulsa. In order to lessen public opposition, the firm entered its first phase in environmental control. The program included installation of dust collector and baghouse on crushing and screening units, paving industry according to specifications of the American Society for Testing and Materials (ASTM). Hallett Construction Co. of Boone, Iowa, entered quarrying operations in the State when they purchased the David quarry of Sooner Rock & Sand Co. At the time of the purchase, improvement of the plant was underway. Planned installation of a new primary jaw crusher, secondary cone crusher, a triple roll tertiary crusher, and an 8- by 12-foot Tyler 3-deck screen and conveyors, was expected to cost $1 million. Amis Materials Co. acquired and began operating a quarry at Stringtown.

Table 6.—Oklahoma: Stone sold or used by producers

(Thousand short tons and thousand dollars)

	1976		1977	
	Quantity	Value	Quantity	Value
Dimension	10	709	9	634
Crushed and broken	19,625	36,630	23,323	46,809
Total	19,635	37,339	23,332	47,443

Table 7.—Oklahoma: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	5,902	11,930	8,072	18,230
Dense-graded roadbase stone	4,831	6,990	5,791	8,893
Cement manufacture	2,323	3,137	2,425	3,790
Surface treatment aggregate	1,338	3,767	1,819	4,951
Bituminous aggregate	1,674	3,471	1,727	3,741
Railroad ballast	1,017	1,488	1,400	2,756
Roadstone	643	1,183	746	1,191
Riprap and jettystone	878	1,726	537	1,177
Agricultural limestone	448	827	458	946
Asphalt filler	32	W	W	W
Macadam aggregate	99	148	W	W
Filter stone	W	W	11	26
Glass manufacture	157	W	--	--
Other uses[2]	283	1,963	338	1,023
Total[3]	19,625	36,630	23,323	46,809

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, sandstone, and miscellaneous stone.

[2] Includes stone used for lime manufacture, fill, mineral food, other filler (1977), unspecified uses (1977), and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Sulfur.—Sulfur was recovered in the processing of natural gas and the refining of crude oil. Sulfur sold or used in 1977 increased by 11% over that in 1976, and the value increased correspondingly 13% in the same period. The Pittston Co. Pioneer Gas at Madill, Sun Oil Co. Duncan refinery, and Texaco, Inc. West Tulsa refinery reported sales.

Tripoli.—Output of tripoli in 1977 from mines in Ottawa County decreased 1% in quantity and 9% in value from those recorded in 1976. American Tripoli Co. (The Carborundum Co.) had one operation from which tripoli was shipped to Seneca, Mo., for processing. Midwestern Minerals shipped the products of its two mines to Rogers, Ark., for processing. Oklahoma Department of Mines recorded four persons employed in mining. Tripoli is a soft, fine-grained, porous microcrystalline silica commonly used as a soft abrasive in buffing, polishing, and in filling compounds. It has also been used as foundry facings and as a component of oilwell drilling mud. According to the Oklahoma Geological Survey, tripoli deposits are stratiform in cherty limestones of the Boone Formation of Mississippian age. Tripoli grades to both surrounding chert and included chert nodules on both gross and detailed scales.

METALS

Boron.—Recovery of boron-10 metal was underway in a modified plant at Eagle-Picher Industries, Inc.'s, Quapaw installation. Erection of new facilities was begun to allow the firm to fulfill its contractual obligations with Energy Research and Development Administration (ERDA/DOE).

Uranium.—The ERDA/DOE national uranium resource assessment involved studies of surface and underground waters and stream sediments by Union Carbide Corp. and investigation of uranium deposits in north-central and central-western Oklahoma by the Oklahoma Geological Survey. Kerr-McGee Nuclear Corp. continued producing uranium hexafluoride at its Sequoyah facility near Gore.

Zinc and Lead.—Eby Mining Co. continued cleanup operations at its Buffalo Calf mine in Ottawa County. In 1977, zinc recovered from ores of the Buffalo Calf mine decreased in quantity and value from those of the previous year. Contrary to the situation in 1976, recovery of lead was reported. No mine production has been reported from the abandoned zinc and lead mines in Ottawa County in recent years. Water, rising rapidly in the mines since shutdown of pumps by Eagle-Picher several years ago, was monitored by the U.S. Geological Survey Water Resources Division. Water is expected to completely fill the mines in a few years. National Zinc Co. operated its electrolytic zinc refinery at Bartlesville. A spill of sulfur dioxide into the atmosphere in July due to overloading of circuits resulted in orders from the State Air Quality Service to install systems to warn of such impending conditions. Responding to local requests, EPA warned Bartlesville residents of possible metal poisoning from eating locally grown and processed vegetables and meats. The State Health Department failed to find evidence of metal contamination in samples of such foods.

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[1] State Liaison Officer, Bureau of Mines, Oklahoma City, Okla.

[2] Geologist, Oklahoma Geological Survey, Norman, Okla.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon black: Continental Carbon Co	Box 22085 Houston, TX 77027	Furnace	Kay.
Cement:			
Ideal Basic Industries, Inc.[1,2]	420 Ideal Cement Bldg. Denver, CO 80202	Quarry and plant	Pontotoc.
Martin Marietta Cement Western Div.[1,2]	5350 E. 46th St. Tulsa, OK 74135	do	Rogers.
OKC Corp.[1,2]	Box 68 Pryor, OK 74361	do	Mayes.
Clays:			
Chandler Materials Co	Box 627 Tulsa, OK 74101	Mine and plant	Oklahoma and Rogers.
Commercial Brick Corp	Box 1382 Wewoka, OK 74884	do	Seminole.
Justin Industries Acme Brick Co	Box 425 Fort Worth, TX 76101	do	Canadian, Custer, Oklahoma, Tulsa.
Oklahoma Brick Corp	Box 87 Union City, OK 73090	do	Canadian.
Coal:			
Bill's Coal Co., Inc	Route 1 Welch, OK 74369	Strip mine	Craig and Wagoner.
Carbonex Coal Co	4815 S. Harvard Suite 305 Tulsa, OK 74135	do	Haskell, Muskogee, Rogers.
Garland Coal & Mining Co	Box 186 Fort Smith, AR 72901	do	Haskell and Le Flore.
P & K Coal Co	Box 550 Henryetta, OK 74437	do	Okmulgee.
Peabody Coal Co	301 N. Memorial Dr. St. Louis, MO 63102	do	Craig and Rogers.
Gypsum:			
Harrison Gypsum Co., Inc	Box 336 Lindsay, OK 73052	Quarry	Caddo.
Republic Gypsum Co	Box 750 Dallas, TX 75221	Quarry and plant	Jackson.
Temple Gypsum	Box 1270 West Memphis, AR 72301	Quarry	Comanche.
United States Gypsum Co	101 S. Wacker Dr. Chicago, IL 60606	Quarry and plant	Blaine.
United States Steel Corp	600 Grant St. Pittsburgh, PA 15230	Quarry	Do.
Lime: St. Clair Lime Co	Box 569 Sallisaw, OK 74955	Plant and quarry	Sequoyah.
Natural gas and petroleum:[3]			
Pumice (volcanic ash): Axtell Mining Corp.	Laverne, OK 73848	Open pit	Beaver.
Salt:			
Acme Salt Co	Box 420 Erick, OK 73645	Solar evaporation	Woods.
Blackmon Salt Co	Route 1 Freedom, OK 73842	do	Harmon.
Sand and gravel:			
Arkhola Sand & Gravel Co.[2]	Box 1627 Fort Smith, AR 72902	Pit and plant	McCurtain.
The Dolese Co.[2]	Box 677 Oklahoma City, OK 73101	do	Canadian, Garfield, Kingfisher, Logan, McClain.
E & A Materials	Box 365 Wichita Falls, TX 76307	do	Cotton.
General Materials Co., Inc	Box 24044 Oklahoma City, OK 73124	do	Oklahoma.
McMichael Concrete Co.[2]	Box 9486 Tulsa, OK 74107	do	Tulsa.
Mohawk Rock and Sand Co	Box 640 Sand Springs, OK 74063	do	Do.
Pennsylvania Glass Sand Corp., Oklahoma Works.	Box 36 Mill Creek, OK 74856	do	Johnston.
Shoffner Sand of Oklahoma, Inc	Box 863 Edmond, OK 73034	do	Oklahoma.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Anchor Stone Co.[4]	Box 1630 Tulsa, OK 74106	Quarry	Tulsa.
Eagle-Picher Industries, Inc	Box 9 Cardin, OK 74335	Rock waste recovery	Ottawa.
Hallett Construction Co	Box 13 Boone, IA 50036	Quarry	Murray.
Idabel Stone Co	Box 337 Idabel, OK 74745	do	Choctaw and McCurtain.
Lattimore Industries, Inc	Box 1186 Denison, TX 75020	do	Bryan.
Leco Materials, Inc	Drawer D, Admiral Station Tulsa, OK 74115	do	Nowata and Washington.
The Quapaw Co	Box 72 Drumright, OK 74030	do	Creek.
Standard Industries, Inc	Box 15670 Admiral Station Tulsa, OK 74115	do	Kay, Osage, Tulsa.
Youngman, H. D., Contractor	Box 647 Eufaula, OK 74432	do	Choctaw and Haskell.
Tripoli:			
The Carborundum Co	Box 489 Seneca, MO 64865	Pits	Ottawa.
Midwestern Minerals, Inc	Box 831 Rogers, AR 72756	do	Do.

[1] Also clays.
[2] Also stone.
[3] Most of the major oil and gas companies and many smaller companies operate in Oklahoma, and several commercial directories contain lists of them.
[4] Also sand and gravel.

The Mineral Industry of Oregon

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Department of Geology and Mineral Industries for collecting information on all minerals except fuels.

By J. M. West[1]

Mineral production in Oregon was valued at $109.1 million, a decrease of 3% from that of 1976. Nonmetals accounted for 92% of the total value of mineral output, and most of this was in construction products, mainly stone, sand and gravel, and cement. Clays, used mostly in brick and tile products and for cementmaking, declined in tonnage and value. A third cement plant was under construction by the State's only producer. Primary nickel, for which Oregon is the only domestic source, declined in output because of operational problems and because of a lull in nickel markets. The nickel content in ores and concentrates amounted to 14,347 short tons, down 13% from the 1976 output. Gold and silver production rose, mainly because of output at two Baker County mines.

Table 1.—Mineral production in Oregon[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- thousand short tons--	147	$315	119	$193
Copper (recoverable content of ores, etc.) ------short tons--	--	--	6	7
Diatomite ---------- thousand short tons--	W	W	3	W
Gem stones ----------	NA	525	NA	520
Gold----------troy ounces--	28	4	675	100
Nickel (content of ores and concentrates)------short tons--	16,469	W	14,347	W
Pumice ---------- thousand short tons--	1,125	2,311	1,083	2,429
Sand and gravel----------do----	[2]17,554	[2]33,473	15,833	33,127
Silver ---------- thousand troy ounces--	--	--	7	33
Stone ---------- thousand short tons--	20,349	42,686	[3]17,600	[3]39,400
Talc and soapstone ----------short tons--	W	W	721	151
Combined value of cement (masonry and portland), lime, sand and gravel (industrial, 1976), stone (dimension, 1977), tungsten concentrate, and values indicated by symbol W------	XX	33,252	XX	33,172
Total----------	XX	112,566	XX	109,132
Total 1967 constant dollars ----------	XX	57,780	XX	[p]53,868

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes industrial sand; value included in "Combined value" figure.

[3]Excludes dimension stone; value included in "Combined value" figure.

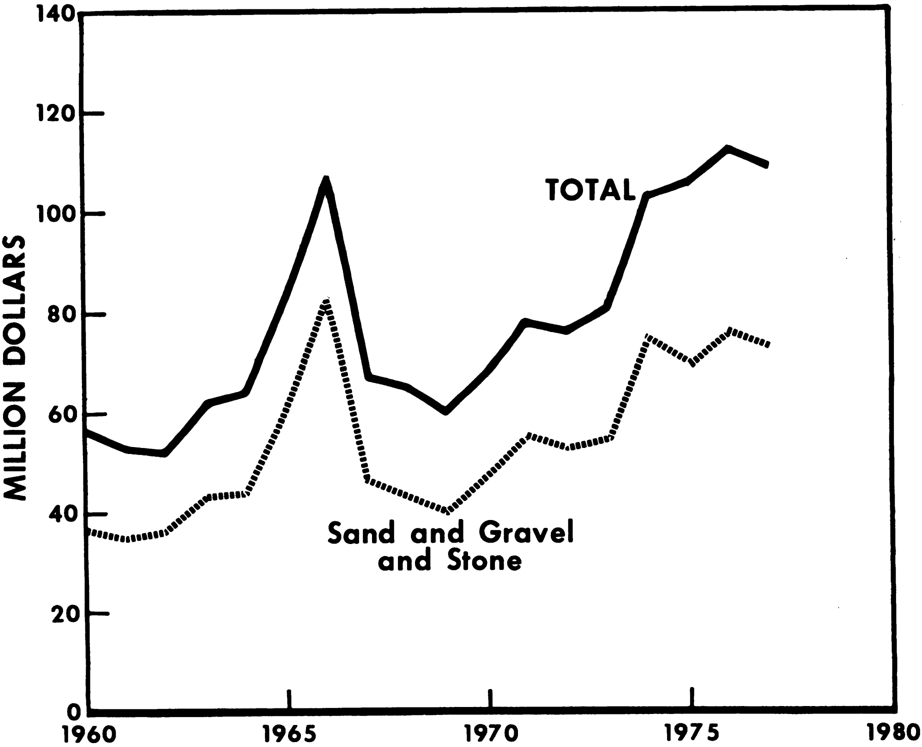

Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Oregon.

Table 2.—Value of mineral production in Oregon, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Baker	$10,587	$12,118	Cement, stone, sand and gravel, gold, clays, silver, pumice, copper, tungsten.
Benton	W	W	Stone, sand and gravel, clays.
Clackamas	W	W	Cement, sand and gravel, stone, clays.
Clatsop	1,446	1,289	Stone, sand and gravel.
Columbia	W	W	Sand and gravel, stone.
Coos	722	602	Stone, sand and gravel.
Crook	W	W	Do.
Curry	99	W	Do.
Deschutes	1,978	W	Pumice, sand and gravel.
Douglas	W	W	Nickel, sand and gravel, stone, pumice.
Gilliam	157	W	Sand and gravel, stone.
Grant	W	W	Do.
Harney	363	225	Stone.
Hood River	379	237	Stone, sand and gravel.
Jackson	5,694	W	Sand and gravel, stone, talc.
Jefferson	338	37	Stone.
Josephine	644	W	Sand and gravel, stone, copper, talc, lead.
Klamath	W	W	Stone, sand and gravel, pumice, clays.
Lake	W	W	Diatomite, stone, pumice, sand and gravel.
Lane	7,762	9,095	Stone, sand and gravel.
Lincoln	1,529	1,728	Do.
Linn	1,985	1,152	Sand and gravel, stone.
Malheur	W	W	Lime, sand and gravel, stone.
Marion	1,988	1,809	Sand and gravel, stone.
Morrow	W	377	Do.
Multnomah	10,692	W	Sand and gravel, lime, stone, clays.

See footnotes at end of table.

Table 2.—Value of mineral production in Oregon, by county —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Polk	$476	$521	Stone, sand and gravel.
Sherman	231	66	Stone.
Tillamook	541	323	Stone, sand and gravel.
Umatilla	1,119	1,752	Do.
Union	506	406	Sand and gravel, stone.
Wallowa	184	117	Do.
Wasco	45	160	Stone, sand and gravel.
Washington	W	W	Stone, sand and gravel, clays.
Wheeler	W	W	Stone, sand and gravel.
Yamhill	W	1,622	Do.
Undistributed[1]	63,103	75,498	
Total[2]	112,566	109,132	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes gem stones and stone that cannot be assigned to specific counties, and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Oregon business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,068.0	1,127.0	+5.5
Unemployment	do	102.0	83.0	-18.6
Employment (nonagricultural):				
Mining	do	1.5	1.7	+13.3
Manufacturing	do	193.7	204.7	+5.7
Contract construction	do	36.6	41.5	+13.4
Transportation and public utilities	do	51.2	53.5	+4.5
Wholesale and retail trade	do	210.9	223.7	+6.1
Finance, insurance, real estate	do	51.9	57.0	+9.8
Services	do	151.1	161.9	+7.2
Government	do	181.6	185.5	+2.2
Total nonagricultural employment	do	878.5	929.5	+5.8
Personal income:				
Total	millions	$14,811	$16,651	+12.4
Per capita		$6,368	$7,007	+10.0
Construction activity:				
Number of private and public residential units authorized		29,491	39,133	+32.7
Value of nonresidential construction	millions	$210.9	$267.9	+27.0
Value of State road contract awards	do	$46.2	$109.5	+137.0
Shipments of portland and masonry cement to and within the State	thousand short tons	795	842	+5.9
Mineral production value:				
Total crude mineral value	millions	$112.6	$109.1	-3.1
Value per capita, resident population		$48	$46	-4.2
Value per square mile		$1,161	$1,125	-3.1

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Outputs of primary metallurgical industries in Oregon declined in 1977, partly because of a shortage of electricity brought on by drought conditions. Production was also adversely affected by depressed markets in nickel, an explosion and fire at a titanium plant, and by a strike at a major steel plant. The value of primary metal products was estimated at $0.5 billion in 1977, based on outputs of smelters and refineries. Foundries added at least an equal amount to metallurgical output values.

Exploration for minerals remained at a relatively high level for Oregon, although expenditures were estimated to have declined about $0.5 million from $5.7 million spent in 1976. Most of the decline was due to a lack of deep drilling for geothermal energy in 1977. Widespread surface exploration and geothermal gradient studies continued, however. An estimated $3.6 million was spent in metallic mineral exploration, with most of this going for copper and gold, and the rest for uranium, nickel, and zinc. The Blue Mountains in eastern Oregon received most of the attention; another active area for exploration was in the western Cascade Range east of the Willamette Valley. Petroleum and natural gas exploration amounted to over $2 million and was concentrated in the northern Coast Range, southern Willamette Valley, and northern Harney County, near Burns. Five new oil and gas drilling permits were issued by the State in 1977. Reichhold Energy Corp. received additional permits for an area southwest of Mist, Columbia County, after drilling several unproductive holes; Mobil Oil Co. applied for a permit to drill a 14,000-foot well near Oakland, southwestern Oregon. Collection of offshore seismic data was continued by several companies.

Legislation and Government Programs.—Oregon's Coastal Management Program was approved by the Office of Coastal Zone Management, U.S. Department of Commerce, on June 6, 1977. Approval was based on findings that the program met the requirements of the Federal Coastal Zone Management Act of 1972. The program provides planning processes by which controls over mineral and other development in the coastal area can be applied by the State and/or by local jurisdictions. Planning follows a list of Statewide Goals and Guidelines established by the Oregon Legislature and by the State Land Conservation and Development Commission (LCDC). The LCDC has responsibility for conduct of the program. The area covered in Oregon extends generally inland to the crest of the Coast Range and along estuarine portions of the Columbia River; on the ocean side the area controlled goes seaward to the "extent of State jurisdiction."

Oregon's basic mined land reclamation program, which began in 1972, was augmented by legislation in 1977 authorizing the Department of Geology and Mineral Industries to perform reclamation on abandoned surface-mined areas and authorizing cities and counties to charge fees for mined land reclamation programs administered at the local level. The legislation also increased permit fees for reclamation activities administered by the Department. The State Legislature passed a bill authorizing underground storage of natural gas and permitting condemnation of property for use in underground gas storage. The measure was prompted by recent exploration in Columbia County that showed potential for such storage purposes.

The State Land Board adopted permanent rules for leasing and exploration for metallic and hard minerals on State lands, and established royalty rates at 5% of gross value removed for metallic minerals and uranium and a "fair and reasonable rate" for sand and gravel, stone, or other nonmetals. Offshore leasing of State controlled areas was not covered by the new rules.

An experimental waste-to-oil plant began operation at Albany at midyear under a Federal program for developing a technically feasible process to hydrogenate wood and farm waste products and provide an acceptable petroleum compound for further refining. The design capacity was 6 barrels of oil per day, but owing to technical problems, only intermittent tests were made during the year.

Only one Federal lease sale on a known geothermal resource area was held in Oregon in 1977, and no bids were submitted. The Geo-Heat Utilization Center, in Klamath Falls, conducted research and was making a statewide inventory of low temperature geothermal resources utilizing Federal funds.

The U.S. Forest Service conducted a Roadless Area Review and Evaluation (known as RARE II) program and announced on November 17, 1977, the areas and acreages that would be considered in the studies. About 2.9 million acres was delineated in Oregon. The purpose was to designate areas to be incorporated in wilderness status, which would limit mining and exploration activities.

The State Department of Geology and Mineral Industries published reports during the year on geothermal exploration,[2] studies in Curry County, southwestern Oregon,[3] land use geology covering central Jackson County, also in southwestern Oregon,[4] and geologic hazards in parts of three counties lying south of the Columbia River in north-central Oregon.[5] The first full map of the geology of the eastern half of the State was published.[6]

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Oregon's only cement producer, Oregon Portland Cement Co., reported net sales valued at $37.1 million in 1977 compared with $33.6 million in 1976, a 10% increase. The company operated plants at Oswego, near Portland, and at Lime, near Durkee, in eastern Oregon. Total cement shipments by the company were reported about the same as in 1976. The firm also sold limestone products from its Lake Oswego plant and from a quarry near Durkee, contributing significantly to earnings.

Construction of a third Oregon cement plant was started by the company near Durkee, and progress was reported ahead of schedule, with the expected startup of the new plant in June 1979. The new plant, to cost an estimated $38 million, was to have 550,000 tons per year capacity and will increase total company capacity by 40%. It will use the dry process for cementmaking and burn coal from Wyoming. Expected fuel consumption will be 3 million Btu's per ton of cement, less than half the rate of fuel consumption at the company's existing plants. A four-stage cyclone preheater kiln will be utilized. Dust control equipment, the best currently available, was expected to account for 15% of the total plant cost. Limestone will be supplied from an existing quarry, which also supplies the cement plant at Lime, 13 miles southeast.

Clays.—Clays were produced in Baker, Benton, Clackamas, Klamath, and Multnomah Counties and were used mainly in cement, brick and tile or other clay products, and as animal feed supplement. A bentonite processing mill was under construction by Glen Teague, several miles south of Adrian, in Malheur County, and a mine to supply the mill was being developed about 8 miles south near Succor Creek. Production was expected to be used for ditch and pond linings, well-drilling, and in animal feed.

Diatomaceous Earth.—American Fossil, Inc., expanded production at its Christmas Valley diatomite plant and found good markets for its product as cat litter, with distributors established in many western cities. The company reported sales of about 45,000 pounds of cat litter daily and also marketed a floor-sweeping product and a product used as a base for barbecue cooking. Its processing plant employed 15 people.

Lime.—Ash Grove Cement Co., a producer of lime in the Rivergate district of Portland, began a $2 million expansion to add 160 tons per day to its existing 180-ton-per-day capacity. When completed in October 1978, the plant will consume 680 tons of limestone per day, supplied by ship from deposits on Texada Island, British Columbia. The plant utilized natural gas as fuel, with a backup of light oil, and was installing a heavy oil backup facility.

Perlite.—Supreme Perlite Co. operated its perlite-expanding plant in Multnomah County, using perlite from Colorado and New Mexico sources. The product was sold for insulation, for use as a nursery mix, and for imparting moisture resistance to concrete blocks. Costs of raw materials rose in 1977 because of a $5-per-ton freight rate increase. Perlite was also expanded by Georgia-Pacific Corp. at a Portland location.

Pumice.—On August 25, 1977, a formal complaint was filed by the Bureau of Land Management contesting mining claims of the U.S. Pumice Co., situated in T 17 S, R 8 E, Lane and Deschutes Counties, in the Deschutes and Willamette National Forests and covering about 1,460 acres. The claims were located in the Rock Mesa portion of the Three Sisters Wilderness Area and have been the subject of a lengthy dispute over the claimant's right to mine the pumice found there. At yearend, it appeared the next step was to schedule a hearing before an administrative law judge of the Interior Department.

Sand and Gravel.—Nearly all counties reported production of sand and gravel in 1977, with the principal sources in or near heavily populated areas. Counties leading production were Multnomah, Clackamas, and Lane. Compared with outputs in 1976, quantity and value fell 10% and 1%, respectively.

The U.S. Supreme Court decided on January 12, 1977, to reverse a 1973 decision that ownership of riverbeds was controlled by Federal law. It ruled in the case of the State of Oregon versus Corvallis Sand & Gravel Co. that disputes over riverbed ownerships that do not form interstate boundaries should be decided by State law. The company had been mining on the disputed land for about 50 years. The State sought to recover possession of the land and collect royalties on the total tonnage mined. The question before the Supreme Court was whether the State or the company, owner of land adjoining the river, owned the riverbed. However, the Court did not rule on this question; instead, it sent the case back to State courts, ruling the State can apply its own laws to the case. A State trial court ruled in the State's favor on all parcels of land, except one, and awarded damages in the amount of $80,000.

Citing the Supreme Court decision, the State Land Board was awarded possession of Upper Windsor Island in the Willamette River and a $78,000 judgment against a

Polk County firm, R. C. Parsons & Son Ready Mix Concrete, Inc. The State claimed the island had formerly been the bed of a navigable river, and said the company had removed 310,000 cubic yards of sand and gravel owned by the State.

Table 4.—Oregon: Sand and gravel sold or used by producers

(Short tons and dollars)

	1977		
	Quantity	Value	Value per ton
Sand	4,047,815	8,453,545	2.09
Gravel	11,785,417	24,673,348	2.09
Total or average	15,833,232	33,126,893	2.09

Table 5.—Oregon: Sand and gravel sold or used by producers in 1977, by major use category

(Short tons and dollars)

Use	Quantity	Value	Value per ton
Concrete aggregate	4,052,305	9,111,549	2.25
Concrete products	1,007,223	2,641,043	2.62
Asphaltic concrete	2,661,395	6,183,322	2.32
Roadbase and coverings	5,543,484	11,901,402	2.15
Fill	2,354,774	2,997,394	1.27
Railroad ballast	17,620	32,355	1.84
Other uses	196,431	259,828	1.82
Total or average	15,833,232	33,126,893	2.09

The U.S. Army Corps of Engineers ordered Ross Island Sand & Gravel Co. to stop dredging of dry land areas in a portion of the Ross Island lagoon in Portland, where it was asserted that operations were in violation of a 3-year permit. An area 600 feet long and 200 feet wide was said to have been dredged without Corps approval. State and local officials have sought for several years to obtain title to remaining island areas in the Ross Island section of the Willamette River for inclusion in the Willamette River Greenway. More than 200 acres were said to remain untouched by mining operations, and the site has been designated a nature conservancy area under the State Natural Resources Heritage Program. In September, a tentative agreement was reached between the company and Portland officials that was expected to result eventually in conversion of Ross Island to a city park. A management plan for the island was to be developed by the Parks Branch of the State Department of Transportation.

Kaiser Cement & Gypsum Corp. sold its ready-mix concrete and aggregates operations at Portland to Willamette-Western Corp. In August, Kaiser sold its Santosh, Oreg., aggregates facilities, near Scappoose, to Cascade Aggregates, Inc. The Santosh plant was formerly operated by Glacier Sand & Gravel Co., a Kaiser subsidiary.

Stone.—Production of crushed stone declined 14% to 17.6 million tons valued at $39.4 million in 1977. One company quarried a small quantity of granite for rough blocks in Baker County. Crushed stone was produced by 115 companies at 279 quarries. The U.S. Forest Service was the leading source, followed by L. H. Cobb, the Oregon Highway Department, and Oregon Portland Cement Co.

The Oregon Legislature was urged to take action to halt rock quarrying operations on scenic Yaquina Head, north of Newport on the Oregon coast, at a hearing in March. The quarry was estimated by its owner to contain 4-1/2 million cubic yards of marketable rock valued at $4 per yard. The site was designated an "area of critical State concern," and a task force was assigned to study the problems and make recommendations. A Bureau of Land Management environmental study released in September recommended that 18.1 acres of Federal land near Yaquina Head lighthouse be designated an "outstanding natural area." Action on the proposal was expected in 1978.

Talc.—A soapstone variety of talc was produced by John Pugh in Jackson and Josephine Counties from two deposits. Most of the product was sold in blocks suitable for carving.

Table 6.—Oregon: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	3,113	6,344	8,863	19,340
Dense-graded roadbase stone	4,314	8,405	3,343	6,993
Surface treatment aggregate	7,185	15,370	1,868	3,689
Bituminous aggregate	1,166	2,742	949	2,795
Macadam aggregate	760	2,332	640	1,830
Riprap and jetty stone	2,394	3,913	491	904
Railroad ballast	222	423	473	1,024
Concrete aggregate	333	704	460	1,108
Fill	41	47	38	113
Ferrosilicon	20	265	19	297
Filter stone	W	W	13	35
Other uses[2]	799	2,041	444	1,266
Total[3]	20,348	42,589	17,600	39,400

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes traprock, sandstone, limestone, miscellaneous stone, and granite.

[2] Includes stone used in cement manufacture, lime (1977), glass manufacture, agricultural limestone, mineral food, other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

METALS

Aluminum.—Production of aluminum at two reduction plants in Oregon was 13% lower in 1977 due to electrical power shortages resulting from regional drought conditions. At the Reynolds Metals Co. plant, Troutdale, a 25,000-ton-per-year potline was shut down from April 1977 to February 1978. Martin-Marietta Aluminum, Inc., closed part of one potline at its plant in The Dalles, but was less affected than Reynolds because of purchases of supplemental power from Centralia, Wash., and British Columbia, Canada, sources.

Martin-Marietta agreed with the State Environmental Quality Commission on a plan to install new scrubber equipment to remove fluoride and sulfur dioxide emissions from the plant. The company had appealed for a variance from pollution restrictions scheduled to go into effect in July 1977. The variance was denied, however, after referral to the U.S. Environmental Protection Agency. In a consent agreement with the State, the company was allowed to dump into the Columbia River without penalty an average of 3,000 pounds of fluorides daily, with no single day discharge exceeding 4,500 pounds. A sharp reduction in allowances was expected in 1978. Installation of a dry scrubber system for fluoride and alumina recovery and a wet system for sulfur dioxide emission control were planned in a major modernization beginning in 1978.

Proposed construction of a $400 million aluminum smelter at Umatilla, eastern Oregon, by Alumax Pacific Corp. remained stymied by a requirement by a Portland judge in 1975 for Bonneville Power Administration to prepare an impact statement for the site and to include an overall examination of regional energy requirements. Draft statements were released in September 1977, and after an initial 90-day review period, a 60-day extension was granted for additional public comment. The plant, if and when built, was to employ about 850 persons.

Copper.—A small quantity of byproduct copper was produced from gold and silver mines in Baker and Josephine Counties during 1977. Diamond drilling for copper-molybdenum porphyry ores was conducted at several locations in Oregon. One such site was on the Little North Fork of the Santiam River, Marion County, where Amoco Minerals Co. drilled several holes toward a concealed target. Cominco American, Inc., explored in the Quartzburg area of Linn County for copper and precious metals. Other companies investigating deposits included American Selco, Inc., Canadian Superior Exploration, Ltd., Johns-Manville Corp., Noranda Exploration, Inc., Texasgulf, Inc., Utah International, Inc., and Newmont Exploration, Ltd. Johns-Manville was reported to have found a good copper showing about 10 miles south of Unity, Baker County, near Squaw Butte. The firm also continued exploration of its copper properties in the Elkhorn Mountains at the head of the North Powder River.

Gold and Silver.—The Bald Mountain mine, operated by the Chemical Lime Co., in Baker County, was the principal gold and silver producer followed by the Pole No. 5

mine, operated by Elton B. Taylor, also in Baker County. Lode mining produced 3,059 tons of ore from which 675 ounces of gold and 7,134 ounces of silver were extracted. Ibex Minerals, Inc., produced a small quantity of development ore from the Bayhorse silver mine, near Huntington. W. A. Bowes & Associates continued development work at the Cougar-New York-Independence group of mines near Granite, and began tests of heap-leach gold extraction using cyanide solutions and activated carbon in columns. Dixie Meadow Gold Mines, Inc., tested its heap-leach facilities near Dixie Meadows, Grant County, in preparation for production runs, possibly in 1978.

Lead and Zinc.—Shiny Rock Mining Corp. produced a small amount of ore from the rehabilitated Ruth mine in the North Santiam mining district, Marion County, and re-equipped a 25-ton-per-day flotation mill near Elkhorn. Mill concentrates were stockpiled for later shipment.

Nickel.—Hanna Mining Co. reported a 9% reduction in its Riddle mine and smelter production to 23.9 million pounds of nickel in 1977.[7] The drop resulted from a major rebuilding of a melting furnace and a tramway breakdown which disrupted ore movement from mine to smelter. Plans were announced to suspend operations for a 6-week period in early 1978 owing to depressed nickel markets. Costs were sharply higher in 1977 because of increased electrical rates due to drought conditions. To conserve electrical power, ferrosilicon production for nickel smelting was shut down at Riddle for 4 months, and supplies came from a Washington source.

Exploration and claim-staking continued in Josephine and Curry Counties on nickel and cobalt laterite deposits, some of which were believed to have good potential for future development and mining. A study was being completed by the State Department of Geology and Mineral Industries describing and showing maps of 26 individual deposits. At least five companies were active in investigating the laterites, including California Nickel Co., Hanna Mining Co., Inspiration Development Co., Interamerican Nickel Co., and U.S. Nickel Corp.

At the Albany Research Center of the Bureau of Mines, further studies were conducted on a new metallurgical process for extracting nickel, cobalt, and copper from the laterite ores. Modifications were incorporated into a 1-ton-per-day process development unit, and plans were made to initiate a pilot scale facility to be built and operated under private company cost-sharing contract. A request for proposal was in preparation at yearend for a continuous circuit 5-ton-per-day plant to further test the process. Sample collection for a resource appraisal of the laterites was conducted by Bureau of Mines field personnel in the Rough and Ready, Josephine Creek, Cedar Spring, and other areas, together with compilations of information offered by private companies. The State completed reconnaissance mapping and sampling in northeastern Oregon and found that nickel prospects there were of little or no significance.

Steel.—Production was lower at Oregon Steel Mills, in the Rivergate section of Portland, owing mainly to a 172-day strike, which began September 1. The company, through its parent, Gilmore Steel Corp., had filed a complaint with the Treasury Department, stating that it had been hurt by "dumping" of carbon steel plate by Japanese steelmakers at unfair prices. Because of the aggressive Japanese competition, unsold inventories of carbon steel plate accumulated. In a Treasury ruling in October, the claims of damage were supported, and importers were required to post bonds equal to 32% of the value of shipments to the United States until a final decision of injury could be established. Hearings were scheduled by the U.S. International Trade Commission in January 1978 to obtain additional evidence.

Cascade Steel Rolling Mills, Inc., reported record sales in 1977, more than triple sales in 1976, with much of the increase in the fourth quarter. The plant is located at McMinnville and produced reinforcing bars and ingot mainly from automobile scrap.

Plans were prepared for construction of a steel fabrication plant, which would include a pipe rolling mill and other units at Warrenton, near Astoria. Pacific Fabricators, Inc., a subsidiary of Brown & Root, Inc., proposed to build the plant and employ about 1,200 persons eventually in fabricating offshore oil drilling equipment. Public hearings on the proposal were scheduled for February 1978.

Titanium.—Oregon Metallurgical Corp. (Oremet), after starting up its refurbished titanium sponge facility at Albany, reached 71% of capacity and achieved processing improvements resulting in a superior quality of sponge.[8] However, the plant met with disaster on October 9 when an explosion in the sponge-making facility stopped production and caused property damage estimated at $2.4 million. The unit was expected to be re-equipped and back in operation in mid-1978. Meanwhile, a magnesium plant, which normally supplied metal for titanium reduction, continued operations, and outputs of metal and chlorine were sold. Titanium product sales were reported at $18.2 million, second highest in the company's history.

Tungsten.—DJH Mining Co. in Baker County produced a small quantity of tungsten concentrates.

Uranium.—Western Nuclear, Inc., subsidiary of Phelps Dodge Corp., explored its White King and Lucky Lass uranium properties in the Lakeview area, Lake County. Also, Phillips Petroleum Co., Lucky Mc Uranium Corp., and Polaris Resources, Inc., were actively exploring in the Lakeview area. Several companies examined uranium showings near Trail, in Jackson County; the Opalite-Bretz mercury mine areas in Harney and Malheur Counties, southeastern Oregon, were sites of increased interest in uranium prospecting.

Zirconium.—The Nation's only zirconium sponge and metal producer, Teledyne Wah Chang Albany Corp., maintained its operations despite many challenges from critics of the firm's waste management, pollution control, and health and safety practices. Public hearings were held during the year by the Department of Environmental Quality on various permit issues. Potentially dangerous levels of radioactivity were discovered in plant wastes, and the State Health Division was called in to evaluate the hazards. Radium-226, a soluble form, was found to be a byproduct of zircon chlorination at the plant. Measurements confirmed that levels in some of the wastes exceeded State limits, and a sizable tonnage was ordered removed from the site and the State. A $50-per-day fine was imposed on the company about midyear for violating new Federal limits on discharges of ammonia and other toxic compounds in waste waters. The firm agreed to install a $200,000 ammonia stripper to reduce discharges. A 21-day strike of plant workers ended August 27 with a new 3-year contract.

ENERGY

Geothermal.—Plans for exploration intensified in 1977, with the Oregon Department of Geology and Mineral Industries issuing 20 deep test permits and 9 blanket permits for shallow drilling programs. The Bureau of Land Management issued three pre-lease exploration permits for geophysical surveys in the Alvord Valley and Klamath Falls areas. Leases in force in 1977 covered 170,000 acres of Federal lands, 6,080 acres of State lands, and an estimated 400,000 acres of private lands. Nearly 400,000 acres of known geothermal resource area (KGRA) lands, identified by the U.S. Geological Survey, remained to be offered for Federal lease. Only one area, with 640 acres in Harney County, was offered for lease in 1977, and no bids were received. Court action by environmental interests resulted in postponement of drilling several deep geothermal test wells at Alvord Valley, southeastern Oregon. Meanwhile, seismic and other permissible studies were conducted. A comprehensive investigation of the Mt. Hood area was underway to find viable geothermal sources. An effort to drill at Timberline Lodge was abandoned at the 320-foot level because the hole caved in, but another attempt was expected. RLK Co., which manages the lodge, received the first lease granted for geothermal development on national forest land in Oregon.

Northwest Natural Gas Co., exploring at Old Maid Flat, near Zigzag, suspended drilling in early winter at 1,900 feet, which was close to planned depth. Federal funding was expected in 1978 to extend drilling to 4,000 feet as part of an overall Mt. Hood geothermal study. Other areas under study included Breitenbush and Austin Hot Springs, in the western Cascade Mountains, Glass Buttes, in the area west of Burns, and Klamath Falls, southern Oregon. Reports were issued on a number of geothermal studies during 1977.[9]

Other.—Construction of a $500 million coal-fired powerplant by Portland General Electric Co. near Boardman was on schedule and due for completion by mid-1980. Dresser Industries, Inc., received a $23 million contract to supply air pollution control equipment for the plant. Five new oil and gas drilling permits were issued by the State in 1977. One went to Mobil Oil Co. to drill a 14,000-foot-deep test well near Oakland, southwestern Oregon. Northwest Natural Gas Co. dedicated a $15 million liquefied natural gas storage facility at Newport on the Oregon coast. Pipeline gas was liquefied and stored initially because of frustrated attempts to obtain supplies by ship as originally planned. Portland General Electric Co.'s planned Pebble Springs nuclear electric plant made little progress during the year owing to continued hearings and debate over its certification by the State.

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[1] State Liaison Officer, Bureau of Mines, Salem, Oreg.

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[7] The Hanna Mining Co. Annual Report 1977. P. 8.

[8] Oremet 1977 Annual Report. P. 1.

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———.Aeromagnetic Map of Mt. Hood and Vicinity, Oregon. Open-File Rept. 77-819, 1977.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Martin Marietta Aluminum, Inc	11300 Rockville Pike Rockville, MD 20852	Smelter	Linn.
Reynolds Metals Co	Troutdale, OR 97060	Plant	Multnomah.
Cement:			
Oregon Portland Cement Co.[1]	111 SE. Madison St. Portland, OR 97214	Plants	Baker and Clackamas.
Diatomite:			
American Fossil, Inc	Box 203 Christmas Valley, OR 97638	Mine and plant	Lake.
Ferroalloys:			
National Metallurgical Corp	Springfield, OR 97477	Plant	Lane.
Union Carbide Corp	Portland, OR 97200	do	Multnomah.
Lime:			
Amalgamated Sugar Co	Nyssa, OR 97913	do	Malheur.
Ash Grove Cement Co	101 West 11th St. Kansas City, MO 64105	do	Multnomah.
Nickel:			
Hanna Mining Co	Riddle, OR 97469	do	Douglas.
Perlite (expanded):			
Supreme Perlite Co	4600 North Suttle Rd. Portland, OR 97217	do	Multnomah.
Pumice:			
Central Oregon Pumice Co	5 Greenwood Ave. Bend, OR 97701	Mine and plant	Deschutes.
Graystone Corp	Box 1087 Bend, OR 97701	do	Do.
Sand and gravel:			
Glacier Sand & Gravel Co	5979 East Marginal Way Seattle, WA 98134	do	Multnomah.
Willamette Western Co	Foot North Portsmouth Ave. Portland, OR 97203	Dredge and plant	Do.
Steel:			
Cascade Steel Rolling Mills, Inc	McMinnville, OR 97128	Plant	Yamhill.
Oregon Steel Mills	Portland, OR 97200	do	Multnomah.
Stone:			
L. H. Cobb	8275 SW. 145th Ave. Beaverton, OR 97005	Quarry and plant	Washington.
Progress Quarry, Inc	14515 Scholls Ferry Rd. Beaverton, OR 97005	do	Do.
Rivergate Rock Products	7881 NW. St. Helens Rd. Portland, OR 97229	Quarry	Multnomah.
Rogers Construction Co	Box 16537 Portland, OR 97216	Quarries	Multnomah and Washington.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Talc and soapstone:			
John H. Pugh	2891 Elk Lane Grants Pass, OR 97526	Mine	Josephine.
Vermiculite (exfoliated):			
Supreme Perlite Co	4600 North Suttle Rd. Portland, OR 97217	Plant	Multnomah.
W. R. Grace & Co., Zonolite Division	62 Whittemore Ave. Cambridge, MA 02140	do	Do.
Zirconium:			
Teledyne Wah Chang Albany Corp	Box 460 Albany, OR 97321	do	Linn.

[1] Also stone and clays.

The Mineral Industry of Pennsylvania

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources (DER), under an agreement for collecting information covering mineral production from mines and quarries.

By William Kebblish[1]

Pennsylvania mineral production reached a record output value of $3,044 million, an increase of about $7 million above that of 1976, but $57 million less based on 1967 constant dollars. Compared with that of 1976, increases in value were attained by masonry and portland cement, lime, natural gas, petroleum, and stone. Decreases in value occurred in clays, sand and gravel, and zinc.

Table 1.—Mineral production in Pennsylvania[1]

Mineral		1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Cement:					
Masonry	thousand short tons	379	$16,903	411	$19,927
Portland	do	5,989	185,170	6,162	196,443
Clays[2]	do	2,291	16,037	2,304	13,075
Coal:					
Anthracite	do	6,228	209,234	5,861	205,138
Bituminous	do	85,777	2,173,009	84,639	2,166,685
Gem stones		NA	9	NA	10
Lime	thousand short tons	2,069	68,356	2,007	72,591
Mica (scrap)	do	W	W	1	W
Natural gas	million cubic feet	89,386	61,229	91,717	73,374
Peat	thousand short tons	W	W	16	353
Petroleum (crude)	thousand 42-gallon barrels	3,019	36,700	2,715	38,810
Sand and gravel	thousand short tons	19,038	55,611	18,846	52,578
Stone:					
Crushed	do	63,542	161,250	63,522	163,652
Dimension	do	65	4,639	66	5,362
Zinc (recoverable content of ores, etc.)	short tons	22,280	16,487	22,825	15,703
Combined value of clays (kaolin), copper, iron ore, natural gas liquids, tripoli, and items indicated by symbol W		XX	[r]32,716	XX	20,263
Total		XX	[r]3,037,350	XX	3,043,964
Total 1967 constant dollars		XX	1,559,072	XX	[p]1,502,501

[p]Preliminary [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes kaolin; value included in "Combined value" figure.

Table 2.—Value of mineral production in Pennsylvania, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	W	W	Stone, lime, clays, mica.
Allegheny	$134,474	$25,455	Cement, stone, clays, sand and gravel.
Armstrong	W	9,667	Sand and gravel, stone, clays.
Beaver	W	W	Sand and gravel, clays.
Bedford	W	2,334	Stone, sand and gravel.
Berks	59,430	47,702	Cement, iron ore, stone, sand and gravel, copper, clays.
Blair	W	W	Stone, sand and gravel.
Bradford	W	W	Sand and gravel, stone.
Bucks	W	W	Stone, sand and gravel, clays.
Butler	57,039	26,089	Lime, cement, stone, clays, sand and gravel.
Cambria	284,363	W	Stone.
Cameron	W	W	Sand and gravel.
Carbon	W	W	Sand and gravel, stone.
Centre	W	W	Lime, stone, clays.
Chester	W	W	Stone, lime, clays.
Clarion	W	W	Stone.
Clearfield	181,484	W	Clays, stone, sand and gravel.
Clinton	W	W	Stone, clays, sand and gravel.
Columbia	W	W	Stone, sand and gravel.
Crawford	W	1,549	Sand and gravel.
Cumberland	W	4,544	Stone, sand and gravel, clays.
Dauphin	W	W	Stone, sand and gravel.
Delaware	W	W	Stone.
Elk	W	W	Do.
Erie	W	4,591	Sand and gravel, peat.
Fayette	67,959	W	Stone, clays.
Forest	W	W	Sand and gravel, stone.
Franklin	W	W	Stone, sand and gravel.
Fulton	W	W	Do.
Greene	W	--	
Huntingdon	8,902	W	Sand and gravel, stone.
Indiana	W	W	Stone.
Jefferson	48,996	W	Clays, stone.
Juniata	193	--	
Lackawanna	10,869	W	Stone, sand and gravel, peat.
Lancaster	W	W	Stone, clays, sand and gravel.
Lawrence	W	W	Cement, stone, sand and gravel, clays, peat.
Lebanon	W	W	Lime, stone.
Lehigh	W	W	Cement, zinc, stone.
Luzerne	W	5,041	Stone, sand and gravel, peat.
Lycoming	10,269	W	Sand and gravel.
McKean	W	W	Stone, clays.
Mercer	W	W	Sand and gravel, stone.
Mifflin	W	W	Stone, sand and gravel, lime.
Monroe	W	W	Stone, sand and gravel, clays, peat.
Montgomery	W	W	Stone, lime, cement, clays.
Montour	W	W	Stone.
Northampton	W	W	Cement, stone, sand and gravel.
Northumberland	W	W	Stone, sand and gravel, clays, tripoli.
Perry	W	W	Stone.
Pike	W	W	Stone, sand and gravel, peat.
Potter	W	36	Stone.
Schuylkill	105,872	1,192	Stone, sand and gravel.
Snyder	W	W	Stone.
Somerset	W	W	Stone, clays, sand and gravel.
Sullivan	1,560	--	
Susquehanna	W	1,122	Stone.
Tioga	W	1,468	Stone, sand and gravel.
Union	W	W	Stone, clays.
Venango	23,133	1,137	Sand and gravel.
Warren	6,758	1,365	Do.
Washington	W	--	
Wayne	W	2,010	Stone, sand and gravel.
Westmoreland	W	W	Do.
Wyoming	W	W	Sand and gravel.
York	43,327	47,632	Cement, stone, lime, sand and gravel, clays.
Undistributed[3]	[r]1,992,723	2,861,031	
Total[4]	[r]3,037,350	3,043,964	

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[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Philadelphia County is not listed because no production was reported.

[2] Value of petroleum is based on an average price per barrel for the State.

[3] Includes some natural gas liquids that cannot be assigned to specific counties, natural gas, petroleum, coal, gem stones, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Pennsylvania business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	5,094.0	5,168.0	+1.5
Unemployment do	404.0	398.0	-1.5
Employment (nonagricultural):			
Mining do	48.3	47.2	-2.3
Manufacturing do	1,335.2	1,341.6	+.5
Contract construction do	180.3	181.1	+.4
Transportation and public utilities do	256.5	258.7	+.9
Wholesale and retail trade do	919.3	925.7	+.7
Finance, insurance, real estate do	211.4	217.3	+2.8
Services do	839.7	864.3	+2.9
Government do	721.6	714.3	-1.0
Total nonagricultural employment do	4,512.3	4,550.2	+.8
Personal income:			
Total millions	$75,562	$82,630	+9.4
Per capita	$6,402	$7,011	+9.5
Construction activity:			
Number of private and public residential units authorized	42,111	50,298	+19.4
Value of nonresidential construction millions	$564.4	$464.4	-17.7
Value of State road contract awards do	$199.0	$150.0	-24.6
Shipments of portland and masonry cement to and within the State thousand short tons	3,024	3,126	+3.4
Mineral production value:			
Total crude mineral value millions	[r]$3,037.4	$3,044.0	+.2
Value per capita, resident population	$256	$258	+.8
Value per square mile	$67,085	$67,147	+.1

[p]Preliminary. [r]Revised.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Leading producing counties, with primary commodities in parentheses, were Northampton and Lawrence (cement), Clearfield (clays), Centre (lime), Montgomery, Lancaster, Bucks, Northampton, and Chester Counties (stone).

Pennsylvania led the Nation in smelter production of cadmium, was second in production of crushed stone, and seventh in dimension stone and zinc production.

Legislation and Government Programs.—Legislation approved by the Pennsylvania General Assembly and signed by the Governor on July 25 guarantees landowners that water supplies will not be contaminated or diminished by surface coal mining operations without replacement. Any mine operator affecting a water supply by contamination or diminution shall restore or replace the affected supply with an alternate source of water adequate in quantity and quality for the purposes served by the supply.

The Department of Environmental Resources' (DER) bonding schedule effective February 25, 1977, applies to all coal and noncoal surface mine operations, with the exception of noncoal quarry-type pits where blasting and sloping is necessary to carry out the approved reclamation plan. A bonding schedule for noncoal quarry-type pits is presently being drafted.

DER's amendments to Pennsylvania Code Chapters 121, 123, 124, 127, 129, and 139 became effective August 28, 1977. Amendments pertain to general provisions, standards for contaminants, emission standards for hazardous air pollutants, construction, modification, reactivation, and operation of sources standards for sources and to sampling and testing. The purpose of these amendments are to establish a program for regulating air pollution discharges from coke ovens, to define the term stockpiling, to establish a clear mechanism for evaluating minor fugitive emissions and providing written approval of such emissions, to provide a standard for vinyl chloride, to clarify meaning of section 121.8, and to inform the agriculture industry that DER should not regulate air contaminants from production of agricultural commodities in their unmanufactured state.

Chapter 95 of DER's regulations relating to waste water treatment requirements was proposed and approved during 1977. Waste water treatment will require a minimum of secondary treatment for all wastes.

DER's Chapter 97 deleting discharge requirements for phenols and cyanides, modifying discharge limits for oil-bearing waste waters, and establishing special oil discharge requirements based upon technology installation for petroleum marketing terminals became effective July 24, 1977.

A February 18, 1977, decision by the Pennsylvania Supreme Court required Barnes & Tucker Co. operating in Cambria and Indiana Counties, to treat acid mine drainage discharges from the company's abandoned Lancashire No. 15 mine and to reimburse the Commonwealth for expenses incurred in treatment of mine discharges during court litigations. Lancashire No. 15 mine was closed in 1969 and the Commonwealth had been treating the acid mine discharge to protect the waters in the Susquehanna River since August 1970. In September 1977, Barnes & Tucker filed a brief with the U.S. Supreme Court to reverse the Pennsylvania Supreme Court decision on grounds of a former Pennsylvania State law allowing companies in 1965 to choose between treating mine drainage or closing and sealing the mine.

A pending case before the Greene County Court filed late in 1977 concerned ownership of methane in coal seams. The official opinion, Number 53, of the Pennsylvania Attorney General dated October 31, 1974, stated that those persons who own or have obtained the right to extract gas have the right to assert legal title thereto. This opinion was supported by Mary Cunningham, the plaintiff, but challenged by United States Steel Corp., the defendant.

In early March, Governor Shapp lifted an 8-year ban on offshore drilling for natural gas in Lake Erie and ordered DER to prepare offshore leases for sections of the 430,000 areas under Pennsylvania's jurisdiction.

Environment.—The Environmental Quality Board proposed policies for critical environmental areas for the Commonwealth's Environmental Master Plan which were published in the Pennsylvania Bulletin on January 22, 1977. The policies are not rules or regulations but do provide the foundation for environmentally sensitive growth and development. They also identify environmental concerns which must be studied and considered in the decision-making process. Nine critical areas of concern in the Plan are for prime farmlands, watersheds with high-quality streams, flood plains, coal resources, areas with limited water supply, clean air resource areas, open space in metropolitan areas, geologic areas with development restraints, and areas with carbonate geology.

Detailed land-use maps of the entire Commonwealth were completed in early 1977 by United States Geological Survey under an agreement with DER. The Land Use Data Analysis utilizes high-altitude plane photo imagery to delineate as many as 37 separate land-use categories. A total of 98 maps, 7 for each of the 14 subdivisions within the Commonwealth, are available for review at DER's Topographic and Geologic Survey Bureau.

During 1977, three areas were being studied for inclusion into Pennsylvania Scenic Rivers System. They were Pine Creek from Ansonia to the West Branch of the Susquehanna River, the Lehigh River from the Francis E. Walter Dam to Jim Thorpe, and the Schuylkill River from Port Clinton to Fairmount Dam in Philadelphia. Intent of the Scenic Rivers legislation is to protect and enhance outstanding and unique natural, cultural, aesthetic, and recreational values of designated waterways.

The Commonwealth's air pollution control program received support from a State Supreme Court decision authorizing DER to close a Bethlehem Steel Corp. coke battery in Johnstown. Bethlehem Steel's appeal to the U.S. Supreme Court was refused in early April.

The State Environmental Hearing Board (EHB) discussed two Bethlehem Steel appeals concerning a State order to install emission control devices on six furnaces at the company's Steelton plant.

DER also asked the EHB to assess civil penalties against Wheeling-Pittsburgh Steel Corp. for continuous violations of the State requirement to desulfurize coke oven gas at the Monessen Works located in Westmoreland County.

DER negotiated a consent order and agreement with New Jersey Zinc Co., Palmerton, Carbon County, for the reduction of air pollution from 12 sources at the firm's smelting plant not covered by previous agreements.

In early January, United States Steel signed a 7-year agreement with Federal, State, and local environmental agencies that will require it to spend $600 million to eliminate air pollution from its Clairton Coke Works in Pittsburgh.

At St. Joe Minerals Corp. located at Monaca, construction began in early August on a $12.7 million commercial-size experimental plant for scrubbing sulfur dioxide from coal-fired powerplant stack gas using the Citrate Process developed by the Interior Department's Bureau of Mines. Originally the Citrate Process was developed by the Bureau in the late 1960's to help curb sulfur dioxide (SO_2) emissions from base metal smelters. Construction of the demonstration project will be completed in late 1978 followed by a 1-year period to test emissions.

The Allegheny County Health Department, located in Pittsburgh with jurisdiction to regulation air contaminants within the county, issued a permit to allow Jones &

Laughlin Steel Corp. to replace six obsolete open hearth furnaces at its Pittsburgh Works with two electric furnaces. This replacement will reduce particulate emissions from steelmaking processes by nearly 90%. The City of Philadelphia with its own monitoring and pollution control programs is the only other area in the State with jurisdiction to regulate emissions within its boundaries.

Electric.—A report by the Public Utility Commission predicts power generating capacities will jump 50% in the next 9 years. Power increase is based on utilities planned additions of 2,990 megawatts coal-fired capacity, 820 megawatts of oil-fired power, and 6,864 megawatts of nuclear capacity.

Of the 67 licensed nuclear reactors in the Nation today, 5 are located in Pennsylvania, generating 8% of the State's electrical needs. Six other nuclear plants are under construction. Pennsylvania has a tradition of being the leader in nuclear power with the first plant in the Nation built by the Atomic Energy Commission (AEC) and the Duquesne Light Co. at Shippingport in 1957. Another first occurred in July 1977 when the experimental light water breeder reactor became operational. The Shippingport power center has been shut down for 2 years for installation of the test core for the light water breeder reactor. Conversion costs were estimated in excess of $200 million.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal.—Pennsylvania's bituminous coal production totaled 84.6 million tons, a decrease of 1% compared with that of 1976. Surface mining operations accounted for 53.8% and underground operations, for 44.7% of the total bituminous production; auger and refuse production contributed the remaining 1.5%. Although production from surface mines increased 16% compared with that of 1976, underground production actually decreased 12.5% even though total number of deep-mine employees increased by 700 to 24,779. There were two less deep mines operating in 1977 than in 1976. This trend resulted in reduced productivity per employee for the underground sector.

The total number of strip employees increased 10% to 10,139 with nearly 17% more surface operations than in 1976. This trend may change with passage of Public Law 95-87 known as the "Surface Mining Control and Reclamation Act of 1977" which requires compliance with numerous environmental standards.

Anthracite production has been declining steadily since 1917 when over 100 million tons were produced. The 1977 production totaled 5.06 million tons, a decrease of more than 4% compared with 1976 production. Of the total 1977 production, 10% was from underground mines; 57%, from surface operations; and 33%, from washery and bank production. Leading anthracite-producing counties in declining order of production with percentage of total coal produced were Schuylkill, 52.7%; Luzerne, 23.8%; Northumberland, 14.6%; Carbon, 2.9%; Lackawanna, 2.8%; Sullivan, 1.0%; Columbia, 1.0%; and Bradford and Dauphin, 0.5%.

The improved safety trend in the anthracite field over the past years was reversed on March 1, 1977, when a sudden inundation occurred in the Kocher Coal Co., located near Tower City, Schuylkill County, claimed the lives of nine mine workers. Recovery operations were completed on March 31, followed by a Federal/State investigation as to the cause. In the interim, the Pennsylvania Commissioner of Deep Mine Safety issued a directive increasing the number and depth of test holes in underground mines approaching abandoned areas to eliminate further mine inundations.

In the bituminous region, a fire which began on February 7, 1977, at Bethlehem Steel Corp.'s Revloc Portal No. 32 was brought under control 2 months later after 120 million gallons of water were used to quell a smoldering fire. The fire was apparently started by a roof fall that caused a trolley wire to arc resulting in ignition of mine timbers and eventually the coal seam. Two of Bethlehem's adjacent mines, closed because of the fire, reopened in early April, and in May, Revloc Portal No. 32 resumed operations.

Another underground coal mine fire of major importance occurred in the anthracite region near the town of Centralia. Previously, a fly ash barrier was used to control an outcrop fire from spreading towards city residences. Efforts will again be directed to control the fire and protect surface property from possible effects of subsidence and noxious gases.

Rain began to fall in the Johnstown area late Tuesday evening, July 19, 1977, and continued the following day creating a major disaster. The U.S. Geological Survey stated that streams in the Conemaugh River Valley flowed at rates that could be expected only once in 500 years. At the height of the storm, Stony Creek flowed at a rate of 41 billion gallons of water per day. The Little Conemaugh was gaged at 26 billion gallons per day, and the Laurel Run Dam collapsed releasing 110 million gallons of water causing excessive damage downstream. The Bethlehem Steel plant was closed due to high water and two of the company's coal mines were flooded and two other mines closed due to lack of electricity. Near Seward, the Conemaugh No. 1 and the Florence No. 2 underground coal mines owned by North American Coal were flooded and were expected to reopen at yearend. Pennsylvania Electric Co.'s 137,000-kilowatt plant in Seward was damaged by the flood and didn't reopen until November 25. Pennsylvania Electric also reported 8,000 tons of stockpiled coal washed away by the floodwaters. A month after the flood, the death toll stood at 73. Seventeen others were unaccounted for, 160 people were hospitalized, 2,697 were injured or taken ill, and 4,600 people were homeless.

NONMETALS

Cement.—Portland cement shipments from 16 plants in 7 counties totaled 6.16 million tons valued at $196 million with an average value of $31.88 per ton. Compared with that of 1976, sales of portland cement increased 3% in quantity and 6% in value, with an increase of $0.96 per ton in unit value.

Masonry cement shipments from 14 plants in 8 counties totaled 410,714 tons valued at $19.9 million, with an average value of $48.52 per ton. Compared with that of 1976, sales of masonry cement increased 8% in quantity, 18% in value with an increase in unit value of $3.90 per ton.

Northampton and Lawrence Counties were the largest producers of both portland and masonry cements. Other producing counties in alphabetical order included Allegheny, Berks, Butler, Lehigh, Montgomery, and York. Of the 6,161,919 tons of portland cement sold, 11.6% was used by building material dealers; 22%, concrete product manufacturers; 58.1%, ready-mix companies; 5.8%, highway contractors; 1.6%, other contractors; and less than 1% for government agencies and miscellaneous customers.

Consumption of energy for the 17 producing plants was 404,136,000 cubic feet natural gas, 725,000 42-gallon barrels fuel oil, 1.24 million tons of bituminous coal, and 972,714,000 kilowatt-hours of electricity.

Major producers of portland and masonry cement were Amcord, Inc., Medusa Corp., National Gypsum Co., Penn-Dixie Cement Corp., and United States Steel Corp.

The cement companies are adopting new energy-saving techniques borrowed from the Europeans. The Coplay Cement Manufacturing Co., acquired in 1976 by Eurocem Inc., an American subsidiary of one of the largest French cement manufacturers, the Société des Ciments Francais, is building a $55 million plant at Nazareth with a 1.1-million-ton cement capacity per year. Replacing 11 smaller plants built years ago, the Coplay kilns are huge, measuring 17 feet in diameter with a length of 276 feet. Fuel savings will occur by using coal instead of natural gas or oil. The Nazareth plant has been designed around a four-stage preheater that will pour the crushed limestone, sand, and clay into the kiln at about 1,500° Fahrenheit reducing fuel requirements. Older kilns use 5.5 million Btu's per ton of cement compared with 2.9 million to 3.2 million Btu's per ton of cement in the newer facility.

Lehigh Portland Cement located in Allentown was acquired by Heidelberg Cement, Inc., an American subsidiary of Portland Zementwerke Heidelberg A.G. of West Germany, in October of 1977.

Clays.—During 1977, clay was produced at 67 operations in 23 of Pennsylvania's 67 counties. Production increased less than 1% in quantity, with an 18% decrease in value compared with that of 1976. Unit value per ton was $5.91 compared with $7.22 per ton in 1976.

Clearfield County with 13 operations was the leading clay producer with 309,622 short tons valued at $5,795,870 with a unit value of $18.72 per ton due mainly to a high production of fire clay. Other counties with a high production of clay and shale in order of decreasing production included Lawrence, Beaver, York, Bucks, Armstrong, and Jefferson Counties.

Leading producers in order of decreasing production included Glen-Gery Corp., Veon, Darlington Brick and Clay Products Co., Medusa Corp., Hanley Co., and Resco Products.

Clay was used mainly for common and face brick, fire brick, and portland and other cements. Other minor uses included flue linings, high-alumina refractory pottery, sewer pipe and drain, and quarry and structural tile.

Table 4.—Pennsylvania: Clays[1] sold or used by producers, by use

(Short tons)

Use	1976	1977
Common brick	192,506	249,749
Face brick	862,955	957,680
Firebrick, block and shapes	681,675	473,438
Flue linings	93,807	162,993
Lightweight aggregates	13,642	10,700
Mortar and cement, refractory	30,675	62,525
Portland and other cements	149,774	162,256
Sewer pipe	W	W
Drain, quarry, and structural tile	56,910	58,149
Other uses[2]	111,730	82,720
Exports: Mortar and cement and other refractories	97,812	84,180
Total	2,291,486	2,304,390

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Excludes kaolin.

[2] Includes fertilizers (1976), flower pots (1976), pottery, roofing granules, terra cotta, and data indicated by symbol W.

Gem Stones.—Collectors and dealers collected mineral specimens from several localities, refuse areas, and abandoned quarries throughout the State. The value of the material was estimated to be $10,000, nearly the same as that in 1976.

Graphite.—Two companies in Elk County and one company in Northampton County produced synthetic graphite. Principal uses for the synthetic graphite were for anodes, graphite shapes, crucibles and vessels, and electric motor brushes. Compared with that of 1976, production was 16% less in quantity but 8% more in value.

Gypsum.—One company in Philadelphia County calcined gypsum. Output increased 32%, but value decreased 21%, compared with that of 1976. Calcined gypsum was used mainly for prefabricated products such as regular wallboard, type X wallboard, and lath.

Iodine.—The Whitmoyer Laboratories Inc., Lebanon County, and West Agro Chemical Inc., Washington County, consumed crude iodine in the manufacture of calcium iodate, hydriodic acid, ethylenediamine dihydroidide, and iodofors, which are used in pharmaceuticals, catalysts, stabilizers, and sanitary uses. Iodine consumed was 4% less than that consumed in 1976.

Lime.—Ten plants operated by eight companies in eight counties produced 2 million tons valued at $72.6 million, 3% less in quantity but 6% greater in value than that in 1976. Nearly 84% of the total lime produced and 82% of the total value was attributed to the production of quicklime; hydrate lime accounted for the remaining 16% of the total production and 18% of the total value.

Centre County with three plants was the leading producer in the State with 33% of the total production and 31% of the total value. Other producing counties in alphabetical order were: Adams, Butler, Chester, Lebanon, Mifflin, Montgomery, and York.

The steel industry was the largest consumer of lime. Lesser amounts of lime were used for water purification, sewage treatment, agricultural purposes, and for other purposes.

Dravo Corp. announced in early May a 17-year contract valued at approximately $45 million to supply lime for sulfur dioxide removal at a third unit of the Bruce Mansfield powerplant in Shippingport. Previously, Dravo signed a 20-year contract valued at $200 million to supply lime for units one and two at the Shippingport facility. Other Dravo contracts to supply lime were with the Allegheny Power System Inc. and the Columbus and Southern Ohio Electric Co. Power companies used the lime to scrub sulfur dioxide from stack gases at coal-fired plants.

Table 5.—Pennsylvania: Lime sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Steel, BOF	1,034	32,937	980	34,971
Water purification	258	9,043	255	9,106
Steel, electric	151	4,662	164	5,845
Sewage treatment	94	3,092	120	4,300
Mason's lime	64	1,778	75	2,627
Steel, open-hearth	93	2,983	W	W
Paper and pulp	24	729	39	1,389
Agriculture	66	2,181	24	930
Acid mine water	27	966	W	W
Tanning	7	262	7	249
Petroleum refining	W	W	4	155
Soil stabilization	W	W	2	55
Other uses[1]	252	9,724	337	12,963
Total[2]	2,069	68,356	2,007	72,591

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes refractory dolomite, open-hearth steel furnaces, other chemical uses, finishing lime, alkalies, explosives, sand-lime brick, ore concentration (1977), wire drawing, paint, petrochemicals (1977), sugar refining, coke (1977), glass (1977), other ore concentration (1976), other metallurgy (1976), and uses indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Mica.—Scrap and flake mica was produced by one company in Adams County. Compared with that of 1976, production and value of mica decreased. Mica was used in vacuum tube capacitors and various electrical and nonelectrical items.

Mullite.—One company produced high-temperature sintered mullite in Philadelphia County. Compared with 1976 figures, production increased 136% and value increased 110%. Mullite is a heat-resistant silicate of aluminum used in furnace linings.

Peat.—Peat production totaled 15,803 tons valued at $352,713 with a unit value of $22.32 per ton. Peat was produced by seven companies having eight operations in six counties. Three peat-producing operations were located in Luzerne County and one each in Erie, Lackawanna, Lawrence, Monroe, and Pike Counties.

Peat is a partially decomposed plant matter that has accumulated under water or in a water-saturated environment. Although peat is not classified as a coal, it is the initial stage in the formation of coal from vegetable materials. Virtually all peat is used for agricultural and horticultural purposes to improve the soil. Peat is classified as moss peat, reed-sedge, peat, and humus, according to the materials from which it has been formed and its degree of decomposition. Moss peat is a type that has been formed principally from sphagnum, hypnum, and/or other mosses; reed-sedge peat has originated mainly from reeds, sedges, and other swamp plants; and humus is peat too decomposed for identification of its geological origin.[2]

In Pennsylvania, moss peat comprised 6.3% of the total peat production; reed-sedge, 56.2%; and humus, the remaining 37.5%.

Perlite.—Crude perlite was shipped into the State and expanded at six plants by four companies in six counties. Quantity sold or used in 1977 totaled 34,916 tons with an average value per ton of $99.29 compared with 33,085 tons valued at $81.74 per ton in 1976. Principal uses for the product were for horticulture, construction aggregates, and formed products. Minor uses were for filter aid, low-temperature insulation, fillers, foundry uses, insulating board, castable insulation, and bonding mortars.

Sand and Gravel.—The total output of sand and gravel decreased slightly from 19 million tons in 1976 to 18.8 million tons in 1977. Construction sand and gravel accounted for 94% of the total production, and industrial sand and gravel production, the remaining 6%. Construction sand and gravel was used mainly for concrete aggregate and roadbase and coverings. Other lesser uses were for asphaltic concrete aggregates and other bituminous mixtures, and other uses. Of the 17,727 short tons of construction sand and gravel used, 86% was used for commercial purposes and 14% for government projects. The unit value of construction sand averaged $2.56 per ton and $2.46 per ton for construction gravel. Industrial sand and gravel was used mainly for glass manufacturing, molding, fire and furnace, and foundry uses. Unit price for industrial sand was $7.23 per short ton.

The number of sand and gravel deposits throughout the State totaled 135 of which 33 produced less than 25,000 tons each, 16 deposits produced between 25,000 to 50,000 tons each, 25 deposits produced between 50,000 and 100,000 tons each, and 36 deposits produced between 100,000 and 200,000 tons each. Only three deposits produced in excess of 1 million tons each. The remaining 22 deposits produced between 200,000 and 1 million tons each. Five of the deposits produced industrial sand and gravel and the remaining 130 deposits produced construction sand and gravel.

Sand and gravel was produced in 42 of the State's 67 counties. The leading county was Beaver with 11% of the State's total. Other leading counties in order of decreasing production were Erie, Armstrong, Bucks, and Huntingdon. Collectively, these five counties produced 46% of the State's total.

The leading producers of construction sand and gravel in alphabetical order were Davison Sand & Gravel Corp., Dravo Corp., Erie Sand Steamship Co., Glacial Sand and Gravel Co., and Warner Co.

Leading producers of industrial sand and gravel in alphabetical order were Penn Glass Sand, Medusa Corp., and McCready Inc.

Nearly 70% of the construction sand and gravel was shipped to market by truck; 19%, by water; and the remaining 11% was used at the plant site.

Of the industrial sand and gravel shipped to market, 69% was by truck and 21% by rail.

Table 6.—Pennsylvania: Sand and gravel sold or used, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Allegheny	1	W	W	1	W	W
Armstrong	6	1,960	6,639	6	1,945	6,891
Beaver	4	994	3,088	5	2,144	5,028
Bedford	1	W	W	1	3	7
Berks	2	W	W	2	W	405
Blair	1	W	W	1	W	W
Bradford	4	W	W	4	W	W
Bucks	5	3,469	9,113	4	1,519	2,760
Butler	4	294	847	2	1	W
Cameron	1	W	W	1	W	W
Carbon	3	W	W	2	W	W
Clearfield	--	--	--	1	W	W
Clinton	--	--	--	1	W	W
Columbia	2	W	W	2	300	525
Crawford	6	505	1,228	7	763	1,549
Cumberland	2	W	W	3	262	753
Dauphin	1	W	W	1	W	W
Erie	14	1,954	4,024	15	2,077	4,528
Forest	2	W	W	2	W	W
Franklin	2	W	W	2	W	W
Fulton	1	W	W	1	W	W
Huntingdon	1	W	W	1	W	W
Lackawanna	1	W	W	1	100	175
Lancaster	2	W	W	2	W	W
Lawrence	9	809	2,079	9	727	1,934
Luzerne	5	630	1,549	5	900	2,238
Lycoming	1	W	W	1	W	W
Mercer	3	298	604	3	443	965
Mifflin	1	W	W	1	W	W
Monroe	5	364	970	5	440	860
Northampton	3	680	1,556	2	W	W
Northumberland	1	230	619	1	238	707
Pike	2	W	W	2	W	W
Schuylkill	1	74	319	1	74	299
Somerset	1	W	W	1	W	W
Tioga	6	307	529	5	410	577
Venango	8	587	1,232	8	509	1,137
Warren	11	435	1,027	14	608	1,365
Wayne	4	242	662	3	292	738
Westmoreland	1	W	W	1	W	W
Wyoming	2	W	W	2	W	W
York	3	W	W	3	W	W
Undistributed	--	5,204	19,529	--	5,091	19,137
Total[1]	133	19,038	55,611	135	18,846	52,578

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Data may not add to totals shown because of independent rounding.

Table 7.—Pennsylvania: Sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	9,669	24,886	8,899	22,808
Gravel	8,307	22,971	8,820	21,674
Total[1]	17,975	47,854	17,727	44,482
Industrial sand	1,063	7,757	1,120	8,095
Grand total[1]	19,038	55,611	18,846	52,578

[1]Data may not add to totals shown because of independent rounding.

Table 8.—Pennsylvania: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	7,940	21,366	6,291	16,242
Concrete products (cement blocks, bricks, pipe, etc.)	3,267	8,935	1,500	5,062
Asphaltic concrete aggregates and other bituminous mixtures	3,109	9,778	3,446	8,788
Roadbase and coverings	1,673	3,494	4,258	10,878
Fill	1,465	3,539	1,782	2,252
Railroad ballast	--	--	45	126
Other uses	522	745	405	1,135
Total[1]	17,975	47,854	17,727	44,482

[1]Data may not add to totals shown because of independent rounding.

Stone.—Among the States, Pennsylvania led in production of crushed sandstone, dimension slate, and crushed miscellaneous stone; ranked second in production of crushed stone and dimension sandstone; third in production of dimension miscellaneous stone; and fifth in output of crushed limestone.

Crushed stone was produced by 140 companies at 227 quarries for roadbase aggregate, roadstone, cement, and other uses. Output was about the same as in 1976, 63.5 million tons valued at $163.7 million. Leading producers were Koppers Co., Bethlehem Steel Corp., and New Enterprise Stone & Lime Co.

Dimension stone was produced by 29 companies at 28 quarries for rough construction, dressed flagging, cut stone, and other uses. Compared with that of 1976, output increased 1% to 65,880 short tons valued at $5.4 million. Leading producers of dimension stone were A. Dalley & Sons, Inc., Delaware Quarries, and Media Quarry Co.

The unit value of all stone increased 5 cents per short ton to $2.66 in 1977. Unit value of other types of crushed and broken stone were limestone, $2.60; granite, $4.39; sandstone, $2.87; traprock, $2.30; and other stone, $2.29 per ton. Unit value of all dimension stone increased $10.14 per ton to $81.39 per ton in 1977.

Lancaster County with 4.69 million tons of crushed and broken stone was the leading producer in the State, followed by Montgomery, Bucks, York, Berks, Northampton, and Adams Counties. Collectively, these seven counties produced 46% of the State's total crushed and broken stone.

Northampton County was the leading producer of dimension stone, producing 21,962 tons, followed by Chester, Bucks, and Delaware Counties. Collectively, these four counties produced 82% of the State's dimension stone.

Table 9.—Pennsylvania: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	15,006	34,818	14,704	35,850
Roadstone	10,496	24,350	12,283	27,530
Cement manufacture	8,345	16,551	8,035	15,590
Bituminous aggregate	6,989	18,081	6,462	17,300
Concrete aggregate	6,005	15,236	6,358	16,600
Lime manufacture[2]	3,635	10,703	3,377	9,568
Surface treatment aggregate	3,700	8,196	2,784	6,875
Flux stone	2,778	9,278	2,306	8,026
Railroad ballast	1,306	3,430	1,630	4,646
Agricultural limestone	1,786	8,484	1,550	7,541
Macadam aggregate	1,114	2,418	1,389	3,175
Riprap and jetty stone	910	2,261	984	2,460
Filter stone	78	203	372	1,119
Terrazzo and exposed aggregate	W	W	157	598
Mine dusting	141	1,415	127	1,233
Asphalt filler	W	W	117	777
Other filler	92	1,304	102	1,463
Mineral food	W	W	58	W
Refractory stone	54	623	40	436
Building products	95	223	30	W
Acid neutralization	24	W	9	W
Other uses[3]	986	3,679	647	2,865
Total[4]	63,542	161,250	63,522	163,652

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, sandstone, miscellaneous stone, traprock, and granite.

[2] Includes dead-burned dolomite.

[3] Includes stone used in glass manufacture, abrasives, whiting, waste material, fill, sulfur dioxide (1976), unspecified uses, and uses indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 10.—Pennsylvania: Dimension stone[1] sold or used by producers, by use

Use	1976			1977		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Irregular-shaped stone	15,960	201	$332	18,790	241	$373
Cut stone	10,810	138	387	W	W	W
Dressed flagging	11,160	47	542	10,704	124	569
Roofing slate	5,390	68	934	4,856	53	912
Structural and sanitary purposes	4,786	60	1,191	4,520	50	1,633
Rough monumental	W	W	W	3,583	43	439
Billiard tables	1,772	22	405	2,090	23	451
Rubble	2,519	32	31	1,749	22	19
Flooring slate	W	W	W	1,565	17	197
Rough flagging	1,946	25	55	1,494	19	48
Blackboards	193	2	100	134	1	107
House stone veneer	140	2	4	--	--	--
Other uses[2]	10,430	183	657	16,394	201	614
Total[3]	65,112	780	4,639	65,879	794	5,362

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes sandstone, slate, granite, and miscellaneous stone.

[2] Includes stone used in dressed construction, slate for electrical fixtures, curbing stone (1976), unspecified uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Sulfur.—Three petroleum refineries operated by three companies in Delaware and Philadelphia Counties plus one steel company in Allegheny County produced 82,000 tons of sulfur and sold or used 81,000 tons of sulfur in 1977. Compared with that of 1976, sulfur sold or used decreased nearly 11% in output and value.

Tripoli (Natural Abrasives).—Crude tripoli was mined by Keystone Filler & Manufacturing Co., Northumberland County. Compared with that of 1976, the tonnage sold or used was nearly 43% greater in quantity and 40% greater in value. Tripoli was used mainly for abrasive purposes.

Vermiculite.—Crude vermiculite shipped into the State was exfoliated by three companies: J. P. Austin Associates, Inc., Hyzer & Lewellen, and the W. R. Grace & Co., located in Allegheny, Bucks, and Lawrence Counties, respectively. The total quantity sold or used by producers was 45% greater and 51% more in value compared with that of 1976. Major uses in the building industry were for lightweight concrete aggregate, loose fill insulation, and other purposes.

METALS

Beryllium.—Kawecki-Berylco Industries, Inc., Reading, announced an increase in price of vacuum-grade ferro and nickel columbium master alloys by 13%. The new price will be $13.45 per pound and $16.47 per pound, respectively. The alloys are used to make high-strength nickel and cobalt-based alloys primarily in jet engines. Beryllium copper master alloy also increased in price to $62 per pound of contained beryllium from $59. The company produced specialty metals and chemicals.

Cadmium.—Pennsylvania ranked first among the States in smelter production of cadmium. Production of cadmium in the State increased 27% in quantity and 22% in value compared with that of 1976. Cadmium was used for electroplating parts of appliances, motor vehicles, and machinery, and was produced from smelting of zinc ores.

Copper.—Pennsylvania had a minimal production of copper during 1977. Copper was obtained as a byproduct from processing of other mined minerals.

Iron Ore.—Bethlehem Steel Corp. produced iron ore at its Grace underground mine located in Berks County. Production was reduced 46% compared with that of 1976 because of permanent closure of the underground mining operation on July 30, affecting 850 employees.

The Grace mine was the last iron ore mine operating in the State and with its closure, Pennsylvania steel mills must rely on imports of iron ore from other States or from foreign countries.

Iron Oxide Pigments.—Production occurred in five counties by six companies. United States Steel Corp. produced iron oxide from steel plant dust in Allegheny County. Both Pfizer Inc. and Reichard-Coulston, Inc., located in Northampton County produced natural and synthetic pigments. Other counties in which production occurred included Carbon, Chester, and Montgomery Counties. Production totaled 48,518 short tons valued at $21.2 million compared with 46,584 short tons valued at $17.4 million in 1976. Iron oxide pigments were used in paints, rubber, plastics, concrete products, paper, magnetic ink, fertilizers, and animal food.

Iron and Steel.—Shipments of Pennsylvania pig iron in 1977 totaled 17.3 million tons valued at $3,104 million, a decrease of 4% in total shipments and a 2% decrease in value compared with that of 1976. Types of pig iron produced were basic, bessemer, malleable, and direct castings.

At the beginning of 1977, steel production for the year was estimated at 103 million tons, an increase of 14% over the 1976 total, but in late September, steel companies were feeling the effects of steel imports from foreign countries.

United States Steel filed a petition with the U.S. Treasury Department asking for protection guaranteed by the Anti-Dumping Act of 1921. The petition indicated 20 million tons of foreign steel entering the United States representing 20% of domestic steel consumption. Also filing anti-dumping complaints with the U.S. Treasury Department were Armco Steel Corp., Bethlehem Steel Corp., American Spring Wire Corp., CF&I Steel Corp., and Florida Wire and Cable Co.

In late November, the Pennsylvania Governor met with Washington officials to ease the burden of foreign steel imports, and in early December, a new plan was adopted which would help the steel industry. The plan would have a reference price system setting steel imports within 5% of the full cost of production of the most efficient steel producer in the world plus transportation costs. Selling steel in excess of the reference price would result in appropriate Federal remedies. This plan was expected to reduce imports to 14% of the

U.S. market resulting in employment increases by nearly 25,000.

To help the steel industry, Conrail planned to purchase domestic steel rails in preference to foreign rails. Bethlehem Steel Corp., a Conrail supplier, indicated this decision would help the company's Steelton plant located in Dauphin County.

United States Steel continued to investigate the 4,000-acre Conneaut Lake site for a new steel mill. The property is located on the border between Pennsylvania and Ohio and is expected to produce between 3 million to 4 million tons of steel by 1982. An environmental impact study is currently being conducted at the site by Arthur D. Little Inc., a Massachusetts-based consulting firm.

United States Steel also announced installation of environmental equipment at several of its plants near Pittsburgh. A $125 million project was started on boilers at the Homestead, Irvin, Duquesne, Edgar Thomson, and Clairton plants. Fourteen projects for water quality were also underway and a $22 million desulfurization plant at the Clairton works was started. At the Edgar Thomson and Duquesne plants, dust collection systems were installed. Also included in the 1977 expenditures for area plants were rehabilitation of a coke oven battery at Clairton costing $13 million, improvements to a blast furnace at Edgar Thomson costing $26 million, and installation of a new cooler for the hot strip mill at the Irvin Works costing $5 million.

United States Steel, Republic Steel Corp., and Federal and State agencies also agreed on a plan to reduce water pollution along the Mahoning River which flows into the Beaver River in western Pennsylvania.

Bethlehem Steel Corp., located in Johnstown, announced reductions in employment totaling 3,900 workers due to heavy damage of the plant caused by the July 20 flood. To eliminate further reduction in the work force, the company requested permission from State and Federal environmental agencies to delay expenditures for additional environmental controls; however, Bethlehem planned to spend $7 million for air and water pollution control equipment over the next 2 years.

In late June, Bethlehem announced a new type of coal-carrying rail cars called the coal porter to be built at the Johnstown plant with a capacity of 100 tons each. The design of the coal porter gives the car an extremely low center of gravity, additional capacity, and a more stable ride.

Jones & Laughlin Steel Corp.'s (J&L) $140 million capital improvement program at the Aliquippa steel facility covers additional air pollution controls on two existing batteries of coke ovens and the subsequent replacement of those batteries, air pollution controls on the sinter plant, removal of sulfur from coke oven gas, and a new boiler in the central powerplant. These programs are estimated to reduce particulate emissions from the Aliquippa plant by 78% and sulfur emissions by 87% by 1981.

At yearend, J&L and Youngstown Steel were planning to merge. Youngstown is owned by Lykes Corp. of New Orleans and J&L by LTV Corp. of Dallas, Tex. The combination of J&L and Youngstown, which are respectively the Nation's seventh and eighth largest steelmakers, would create a producer the size of National Steel Corp., the Country's third largest, behind United States Steel and Bethlehem.

Alan Wood Steel Co., located in Conshohocken near Philadelphia, filed a petition for arrangements under Chapter 11 of the Federal Bankruptcy Act on June 11, 1977, and officially closed the steel plant on September 15. The firm's main product was construction-oriented steel plates which was affected mainly by foreign imports. Lukens Steel Co., located in Coatesville, also reported effects of foreign steel imports resulting in reduction of work force.

Wheeling Pittsburgh Steel Corp., located at Monessen, Westmoreland County, planned to construct a rail mill if a $70 million financial arrangement is completed. Under the $70 million agreement, the State would guarantee $10 million; Federal Economic Development Administration, $40 million; and Farmers Home Administration, $20 million.

Babcock and Wilcox Co., one of the Nation's largest producers of coal-fired and nuclear powerplants, is completing a $60 million plant in Ambridge, producing specialty steel tubes for utility, oil, and other markets.

Allegheny Ludlum Steel Corp. plant located at Brackenridge began operating a new $18 million argon oxygen decarburization vessel designed to increase stainless steel capacity by more than 35%. The 100-ton-capacity vessel is the first step in a $31 million expansion project that also calls for completion of a continuous casting process by early 1981.

Ellwood Steel Casting Corp., located in Ellwood City, opened a new facility using latest technology in foundry operations. Previously installed were three high-frequency 2,000-pound induction furnaces and chemical analyses system of furnace charges.

Howmet Aluminum Corp., owned by Pechiney Ugine Kuhlmann Corp., one of Europe's largest aluminum and chemical producers, plans to spend $20 million to build a casting facility and a new reversing mill in Lancaster.

Gulf Oil Corp. acquired Kewanec Industries Inc. of Bryn Mawr, a producer of oil and gas, chemicals, and coal interests. Gulf, located in Pittsburgh, is the Nation's seventh largest industrial company producing petroleum and various minerals.

Slag-Iron and Steel.—Production of iron slag totaled 5,314,074 tons valued at $17.3 million and production of steel slag totaled 1,048,311 tons valued at $2.27 million. Total slag produced equaled 6.4 million tons valued at $19.6 million in 1977.

Iron slag consisted of air-cooled, expanded, and granulated slag. Major use of air-cooled slag was for asphaltic concrete aggregate, roadbase and shoulders, and for concrete aggregate. Expanded slag was used for concrete products, and granulated slag for roadbase and shoulders, fill, and cement manufacture. Steel slag uses were mainly for roadbase and shoulders, fill, and asphaltic concrete aggregate.

Compared with other States, Pennsylvania produced approximately 20% of the national total.

Zinc.—Pennsylvania ranked seventh among the States in the production of zinc, producing 22,825 tons valued at $15.7 million with a unit price of $688 per ton. Compared with that of 1977, production increased 2%, but value decreased nearly 5%. Zinc was used mainly for galvanizing, brass and bronze products, castings, and rolled zinc. Significant quantities of zinc were consumed as pigments or other chemicals.

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[1] State Liaison Officer, Bureau of Mines, Harrisburg, Pa.

[2] Mickelson, D. P. Peat. Ch. in Mineral Facts and Problems. U.S. BuMines Bull. 667, 1975, p. 771.

Table 11.—Pennsylvania: Iron and steel slag sold or used in 1977, by use

Use	Iron blast-furnace slag								Steel slag		Total slag	
	Air-cooled		Expanded		Granulated		Total					
	Quantity (short tons)	Value f.o.b. plant	Quantity (short tons)	Value f.o.b. plant	Quantity (short tons)	Value f.o.b. plant	Quantity (short tons)	Value f.o.b. plant	Quantity (short tons)	Value f.o.b. plant	Quantity (short tons)	Value f.o.b. plant
Concrete aggregate	819,333	$2,707,549	--	--	--	--	819,333	$2,707,549	--	--	819,333	$2,707,549
Concrete products	418,676	1,411,550	W	W	--	--	661,647	2,435,687	--	--	661,647	2,435,687
Coment manufacture	100,000	320,000	--	--	38,540	$101,834	138,540	421,834	--	--	138,540	421,834
Asphaltic concrete aggregate	1,067,590	3,464,128	--	--	--	--	1,067,590	3,464,128	175,000	$393,750	1,242,590	3,857,878
Roadbase and shoulders	981,970	2,969,133	--	--	372,087	915,507	1,354,057	3,884,640	495,436	1,139,820	1,849,493	5,024,460
Fill	514,059	1,485,079	--	--	134,629	379,676	648,688	1,864,755	263,096	459,261	911,784	2,324,016
Railroad ballast	187,000	602,960	--	--	--	--	187,000	602,960	30,000	52,200	217,000	655,160
Mineral wool	20,620	60,512	--	--	--	--	20,620	60,512	--	--	20,620	60,512
Roofing, built-up and shingles	71,167	240,438	--	--	--	--	71,167	240,438	--	--	71,167	240,438
Soil conditioning	--	--	--	--	5,000	13,250	5,000	13,250	--	--	5,000	13,250
Glass manufacture	120,000	1,020,000	--	--	--	--	120,000	1,020,000	--	--	120,000	1,020,000
Fire protection	--	--	--	--	--	--	--	--	15,000	34,500	15,000	34,500
Ice control	27,152	75,920	--	--	--	--	27,152	75,920	--	--	27,152	75,920
Other uses	153,280	426,528	--	--	40,000	107,000	193,280	533,528	69,779	195,112	263,059	728,640
Total	4,480,847	14,783,797	W	W	590,256	1,517,267	5,314,074	17,325,201	1,048,311	2,274,643	6,362,385	19,599,844

W Withheld to avoid disclosing company proprietary data.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives: Satellite Alloy Corp	98 McKnight Rd. Pittsburgh, PA 15237	Plant	Allegheny.
Cement:			
Amcord, Inc.[1]	610 Newport Center Dr. Newport Beach, CA 92660	do	Northampton.
Coplay Cement Manufacturing Co.[1]	Nazareth, PA 18064	do	Lehigh and Northampton.
Keystone Portland Cement Co.[1]	Box 1785 Allentown, PA 18105	do	Northampton.
Louisville Cement Co	501 South 2nd St. Louisville, KY 40202	do	Lawrence.
Medusa Corp.[1,2]	Box 5668 Cleveland, OH 44101	do	Lawrence and York.
Penn-Dixie Industries, Inc.[1,2]	60 East 42nd St. New York, NY 10017	do	Butler and Northampton.
United States Steel Corp.[1,3]	600 Grant St. Pittsburgh, PA 15230	do	Allegheny and Northampton.
Clays:			
Dresser Industries, Inc	Box 6504 Houston, TX 77005	Pit	Clearfield and Somerset.
Glen-Gery Corp	227 North 5th St. Reading, PA 19601	Pit	Adams, Berks, Northumberland, Union, York.
Hanley Co	28 Kennedy St. Bradford, PA 16701	Pit	Jefferson and McKean.
Resco Products	Box 108 Morristown, PA 19404	Pit	Clearfield and Huntingdon.
Coal, anthracite:			
Greenwood Stripping Corp	1 Venice St. Nesquehoning, PA 18240	Strip mine	Carbon and Schuylkill.
Jeddo-Highland Coal Co	800 Exeter Ave. West Pittston, PA 18643	Strip mine and culm bank.	Luzerne.
Leon East Kocher Coal Co	Box 127 Valley View, PA 17983	Underground mine.	Schuylkill.
Reading Anthracite Co	200 Mahantongo St. Pottsville, PA 17901	Culm bank and strip mine.	Northumberland and Schuylkill.
Coal, bituminous:			
Barnes & Tucker Co	357 Lancaster Ave. Haverford, PA 19041	Underground mine.	Cambria.
Bethlehem Mines Corp.[4,5]	701 East 3rd St. Bethlehem, PA 18016	do	Cambria and Washington.
C&K Coal Co	Box 69 Clarion, PA 16214	do	Greene.
Pittsburg & Midway Coal Co	Tenmain Center Kansas City, MO 64105	do	Washington.
Graphite, synthetic:			
Air Reduction Co., Inc	Theresia St. St. Marys, PA 15857	Plant	Elk.
Charles Pfizer & Co. Inc.[5]	235 East 42nd St. New York, NY 10017	do	Northampton.
Stackpole Carbon Co	St. Marys, PA 15857	do	Elk.
Gypsum, calcined: United States Gypsum Co.[6]	101 South Wacker Dr. Chicago, IL 60606	do	Philadelphia.
Iron oxide pigments:			
The Prince Manufacturing Co	Bowmanstown, PA 18030	do	Carbon.
Reichard-Coulston, Inc	15 East 26th St. New York, NY 10010	do	Northampton.
Lime:			
The J. E. Baker Co.[1]	Box 1189 York, PA 17405	do	York.
Mercer Lime & Stone Co	1640 Oliver Bldg. Pittsburgh, PA 15222	do	Butler.
National Gypsum Co.[1,2,7]	325 Delaware Ave. Buffalo, NY 14202	do	Centre.
Peat:			
Gouldsboro-Wayne Peat Co	Box 68 Gouldsboro, PA 18424	Moss	Wayne.
Lake Benton Peat Moss	1418 North Main St. Scranton, PA 18508	Bog	Lackawanna.
Perlite, expanded:			
Armstrong Cork Co	Lancaster, PA 17603	Plant	Lancaster.
Atlantic Perlite	Box 345 Primrose, PA 19018	do	Delaware.
Pennsylvania Perlite Corp	Box 2002 Lehigh Valley, PA 18001	do	Lehigh and York.
Perlite Manufacturing Co	Box 478 Carnegie, PA 15106	do	Allegheny.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Davison Sand and Gravel Co	34th Ave. & 4th St. New Kensington, PA 15068	Dredge	Westmoreland.
Dravo Corp	One Oliver Plaza Pittsburgh, PA 15222	do	Beaver.
Erie Sand Steamship Co	Erie, PA 16500	do	Lycoming.
Shippingport Sand & Gravel Co	1200 Slambaugh Bldg. Youngstown, OH 44501	Pit	Armstrong.
Warner Co.[1] [4]	1721 Arch St. Philadelphia, PA 19103	Pit	Bucks.
Stone:			
G & West H. Corson, Inc.[4]	Plymouth Meeting, PA 19462	Quarry	Montgomery.
The General Crushed Stone Co	712 Drake Bldg. Easton, PA 18042	do	Bucks, Chester, Delaware, Lancaster, Luzerne, Perry.
Glasgow Quarry, Inc	Route 2, Box 121 Glasgow, MO 65254	do	Montgomery.
Martin Marietta Corp	11300 Rockville Pike Rockville, MD 20852	do	Centre, Chester, Fayette, Northampton.
New Enterprise Stone & Lime	New Enterprise, PA 16664	do	Bedford, Blair, Cumberland, Franklin, Huntingdon, Somerset.
Sulfur:			
Atlantic Richfield Co	3144 Passyunk Ave. Philadelphia, PA 19145	Plant	Philadelphia.
British Petroleum Corp., Ltd	Box 428 Marcus Hook, PA 19061	do	Delaware.
Gulf Oil Corp	Box 7408 Philadelphia, PA 19101	do	Philadelphia.
Sun Oil Co	1608 Walnut St. Philadelphia, PA 19103	do	Delaware.
Tripoli: Keystone Filler & Manufacturing Co.	Muncy, PA 17756	Pit	Northumberland.
Vermiculite, exfoliated:			
Hyzer & Lewellen	Box 155 Southampton, PA 18966	Plant	Bucks.
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	do	Lawrence.

[1] Also stone.
[2] Also clays.
[3] Also coal.
[4] Also lime.
[5] Also iron ore.
[6] Also expanded perlite.
[7] Also cement.

The Mineral Industry of Puerto Rico, the Virgin Islands, and Pacific Island Possessions

The Puerto Rico section of this chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines and the Geological Survey, U.S. Department of the Interior, and the following Commonwealth of Puerto Rico agencies: Department of Natural Resources and the Environmental Quality Board.

By John W. Sweeney[1]

PUERTO RICO

Puerto Rico's mineral production, virtually all construction materials, has a direct relationship to construction and business activity on the island. The construction industry in Puerto Rico for the past several years has experienced a decline, although there were slight signs of recovery in 1977. The trend over the past several years has been a decrease in output of construction materials while the values have increased. This increase in value can probably be attributed to inflation. Unemployment in Puerto Rico continued at a record high level of 20% in 1977, with unemployment in the

Table 1.—Mineral production in Puerto Rico[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland ____________ thousand short tons__	1,545	$66,150	1,367	$67,775
Clays ________________do____	W	W	272	387
Lime________________do____	28	2,513	40	3,007
Salt ________________do____	27	639	27	639
Sand and gravel ________________do____	NA	NA	[e]12,000	[e]21,000
Stone:				
Crushed________________do____	13,247	45,609	12,043	42,648
Dimension ________________do____	157	1,515	144	1,633
Total ________________	XX	[2]116,426	XX	137,089
Total 1967 constant dollars ________________	XX	59,761	XX	[p]67,667

[e]Estimate. [p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Total of listed items only; excludes value of common clay, which has been withheld to avoid disclosing company proprietary data.

construction industry the highest of all other sectors at 48%.

The Government of Puerto Rico has established effective control measures to prevent and solve current environmental degradation problems to ensure the welfare, social amenities, and related needs of the community. Water supply is indispensable for the adequate performance of domestic, industrial, agricultural, and construction activities. With respect to industrial effluents, all industries are legally required to pretreat their wastewaters to properly dispose of their wasteload.

Table 2.—Value of mineral production in Puerto Rico, by district

(Thousands)

Senatorial district	1976	1977	Minerals produced in 1977 in order of value
Aguadilla	W	$981	Stone.
Arecibo	$37	W	Do.
Humacao	W	W	Do.
Mayaguez	2,957	2,781	Stone, salt.
Ponce	W	W	Cement, lime, stone, clays.
San Juan	W	W	Cement, stone, clays.
Undistributed[1]	113,433	133,324	
Total[2]	[3]116,426	137,089	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes some stone and sand and gravel that cannot be assigned to specific districts, and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

[3] Incomplete totals exclude value of common clay.

Table 3.—Exclusive prospecting permits in Puerto Rico, December 31, 1977

Permit holder	Date	Parent company	Minerals
Jorge Luis Blanco	Dec. 11, 1975		Gold and silver.
Ponce Mining Co	May 15, 1961	AMAX, Inc	Copper.
Cobre Caribe S.A	Aug. 5, 1963	Kennecott Copper Corp	Do.
Francis O'Kelly	Apr. 19, 1977		Gold.

A plan for improving water quality will be developed pursuant to Section 208 of Federal Water Pollution Control Act Amendments of 1972. This plan is specially addressed to water pollution control in Puerto Rico and to control of pollution hazards resulting from mining activities. Section 208 of Federal Law provides for the establishment of a regional plan of water pollution control related to problems of highly dense industrial urban zones.

During the past years, Puerto Rico experienced increasing air pollution problems; some were generated by emission sources located adjacent to residential areas. Major contributors to air pollution are: Electric generation, petroleum refining, the cement industry, cane sugar production and processing, and related operations.

In order to have an overview of air pollution problems caused by the emission sources operating on the Island, the Environmental Quality Board (EQB) conducted a surveillance program comprising 15 monitoring stations to obtain areawide air quality data. Recent gathered data were compared to given emission levels of pollutants according to air standards or criteria (total suspended particles, sulfur dioxide, and nitrogen oxides).

In August 1977, the Federal Clean Air Act was amended and the States must update implementation plans in accordance with the Act. EQB has been required to develop stringent regulations or strategies which will improve the air quality. As stated in the Clean Air Act, those new measures adopted by the State Implementation Plan (SIP) must be submitted to the Environmental Protection Agency (EPA) prior to January 1979, even though there are different factors which deter the implementation of the standards in Puerto Rico.

The development of the Utuado-Lares porphyry copper deposits continues to be a point of discussion between the Puerto Rican Government and the Kennecott-AMAX partnership. The deposits collectively contain 243 million short tons of copper ore, averaging 0.72% copper with additional recoverable values of gold and silver. Due to recent depressed copper prices, a reexamination of the project in light of increased costs is now required.

The Government and the mining companies have a preliminary agreement that would give each a one-third interest during the first 10 years of operation in order for the companies to recover their initial investment. After the 10th year of operation, the Commonwealth could purchase up to 51% of the total stock, leaving each of the companies with 24.5%. The companies have also agreed in principle to process the copper in Puerto Rico although the extent will depend on the new assessment.

The Commonwealth Government and Universal Oil Products Co. (UOP) continued an evaluation of the Guanjibo nickel laterites near Mayaguez. UOP continued bench-scale tests on the laterites to develop recovery data. The company would like to obtain guarantees for operations prior to doing a full feasibility study. Timing for the development of these deposits is becoming critical due to increasing urbanization in the area. One deposit has already been lost because a hospital has been built on it.

Geological studies off Puerto Rico's north coast, east of Manati have indicated geological structures favorable for the accumulation of oil. The Commonwealth government is currently trying to determine the best course of action; that is, to have private industry explore and develop the potential oil on a lease royalty basis or for the government to take the risk themselves and to reap the greater reward should oil be found. A decision is expected in 1978.

The Commonwealth Oil Refining Company (CORCO), one of Puerto Rico's largest private enterprises and one of the biggest U.S. oil companies, found itself in dire economic condition and was on the verge of bankruptcy at yearend. Operations were nearly halted when CORCO was unable to pay for its crude oil purchases, and Ashland Oil, Inc., kept the operation going with emergency supplies while considering a takeover. Negotiations for the takeover continued through yearend.

The pirating of sand from the beaches continued to be a growing problem in Puerto Rico, resulting in severe erosion of some of the island beaches. The Commonwealth Department of Natural Resources has taken positive action by developing a Rangers Corps to monitor the beaches in an effort to eliminate the problem. Because of the limited amounts of natural fine aggregate for concrete construction, several studies over the years have been conducted to determine the feasibility of manufacturing sand substitutes in Puerto Rico, all with positive results.

The Coastal Zone Management Act (Section 307) calls for interagency coordination and cooperation between the U.S. Department of Commerce and other interested Federal agencies. Title 15, Code of Federal Regulations 923115, specifies that participating States consult with the Federal Bureau of Mines, as a cognizant Federal agency, concerning national interest questions on mineral resources. The Federal Bureau of Mines has reviewed Puerto Rico's Coastal Zone Management Program First Review Draft and submitted review comments suggesting that in developing a comprehensive program the following items, with respect to mineral resources, should be addressed:

1. What are the mineral resources/reserves in the program area?
2. Identify minerals processing plants in the program area.
3. What are the future mineral requirements needs of the program area?
4. What are the future mineral resource development potential and its impact in the program area?
5. Identify permissible mineral resources/mineral processing use in the program area.

Government Programs.—The Geologic Division of the U.S. Geological Survey and the Department of Natural Resources of Puerto Rico jointly conduct a program in marine geology designed to (1) produce marine geologic maps of the insular shelf surrounding Puerto Rico, (2) conduct geologic research on processes operating on the insular shelf, (3) conduct mineral resources appraisals, notably for sand and gravel, on the insular shelf, and (4) train Puerto Rican technicians and scientists in the techniques of marine scientific investigations.

The project has its headquarters at the Department of Natural Resources building at San Juan and currently has a staff of two geologists, two cartographic technicians, a secretary, and a draftsman; some of these positions are part-time. For its work at sea, the program staff uses the research vessel *Jean A.*, a well-equipped 65-foot, twin-screw workboat.

Current emphasis is on producing geologic maps of the center-south and nearly all of the north coastal shelf; on studying the processes active at the Escollo de Arenas, a prominent sand shoal in the Roosevelt Roads area, Vieques; and on evaluating offshore sand resources of the Cabo Rojo area.

The Caribbean District of the Water Resources Division of the U.S. Geological Survey published two Water-Resources Investigations Reports,[2] four open-file reports,[3] and one Water-Supply Paper during 1977.[4]

REVIEW BY MINERAL COMMODITIES

Cement.—The Puerto Rico Department of Consumer Affairs granted a price increase for bagged cement sold at retail. The new price is $2.93 per bag at the producer level, an increase of 24 cents per bag. The price for bulk cement remains at $2.62 per bag. The increase was attributed to higher costs of fuel and electricity.[5]

According to Puerto Rican Cement Co., Inc.'s 1977 Annual Report, the company sold 19,874,000 bags of cement in Puerto Rico during the year, accounting for 68.3% of the island's consumption. In 1976, it sold 20,235,000 bags, or 67% of the island's consumption. Export sales amounted to 1,128,000 bags, mostly to the smaller Caribbean islands. Shipments to Venezuela and the Dominican Republic were discontinued after the sale of the company's cement-carrying vessel. The company produced 20,996,000 bags of gray cement in 1977 compared with 22,598,000 bags in 1976. Three of the six kilns operated at the Ponce plant, which has an annual capacity to produce 24 million bags. Should demand for cement increase, the capacity at the Ponce plant could be increased to 30 million bags annually.

Table 4.—Puerto Rico: Portland cement statistics

(Short tons)

	1976	1977
Number of active plants	3	2
Production	1,545,318	1,412,594
Shipments from mills:		
Quantity	1,557,982	1,367,489
Value	$66,150,305	$67,774,603
Stocks at mills, Dec. 31	31,108	32,577

Table 5.—Puerto Rico: Crushed stone sold or used by producers,[1] by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	8,136	35,340	7,721	33,680
Cement manufacture	3,066	4,737	W	W
Concrete aggregate	1,396	3,781	1,043	2,717
Bituminous aggregate	277	801	202	607
Dense-graded roadbase stone	254	563	180	403
Terrazzo and exposed aggregate	30	152	57	281
Lime manufacture	29	48	W	W
Soil conditioners	W	20	W	W
Other uses[2]	60	163	2,839	4,962
Total[3]	13,247	45,609	12,043	42,648

W Withheld to avoid disclosing company proprietary data; included with "Other uses."
[1] Includes limestone, traprock, granite, and marble.
[2] Includes stone used for macadam aggregate, asphalt filler, surface treatment aggregate, riprap and jetty stone (1976), other fillers or extenders (1976), and uses indicated by symbol W.
[3] Data may not add to totals shown because of independent rounding.

Clays.—Puerto Rican Cement Co. and San Juan Cement Co. Inc., produced common clay for use in cement manufacture. Output and value decreased 18% and 6%, respectively, from those of 1976.

Graphite.—Union Carbide produced synthetic graphite at its Puerto Rican plant for the manufacture of electrodes.

Lime.—Puerto Rican Cement Co., Inc., produced lime at Ponce for mason's lime, sugar refining, and other uses. Output was 39,979 tons, an increase of 41% over that of 1976. The lime was consumed in Puerto Rico and the Virgin Islands.

Salt.—Sal-de Borinquen, Ponce Salt Industries, and Guanica produced salt from seawater by solar evaporation near Mayaguez. Production of salt was estimated at 27,000 tons valued at $639,000 in 1977.

Sand and Gravel.—Sand and gravel was produced in Puerto Rico for construction purposes by both commercial operators and government-and-contractor operators. Sand was also exported to the Virgin Islands for use in construction. The Puerto Rican government, through its Department of Natural Resources, collects a royalty for sand and gravel produced from public lands. The royalty payment through December 1977 was 15 cents per cubic meter; after December 1977, new regulations set the royalty at 45 cents per cubic meter. According to the Department of Natural Resources, 1,001,067 cubic meters of sand and gravel valued at $4.8 million was produced in 1977.

Stone.—Crushed limestone, marble, and traprock were produced in Puerto Rico in 1977. The crushed stone was produced by 26 companies at 126 quarries for roadstone (64%), concrete aggregate (9%), bituminous aggregate (2%), and the remainder of uses (25%). Output decreased 9% to 12 million tons valued at $42.6 million. Leading producers were Puerto Rican Cement Co., Inc., and San Juan Cement Co., Inc. Dimension stone was produced for rough construction stone and rough blocks. Leading producers were Medina Victorio Barrios and Cantera Ferrer, Inc. Output was 143,700 tons valued at $1.6 million.

Sulfur.—Elemental sulfur was recovered as a byproduct by Puerto Rico Sun Oil Co. and the Commonwealth Oil Refining Co., Inc., at its petroleum refineries. The value of byproduct sulfur is not included in table 1.

VIRGIN ISLANDS

The U.S. Virgin Islands, located in the Caribbean, are about 40 miles east of Puerto Rico. They consist of about 50 islands and cays that are part of the Antilles and form the border between the Caribbean Sea and the Atlantic Ocean. The three main islands, St. Croix, St. Thomas, and St. John, contain an estimated 100,000 inhabitants and dominate the commercial activity of the group.

The Hess Oil Virgin Islands Corp. continued operating its refinery and recovered elemental sulfur in the process.

The Virgin Islands Conservation and Cultural Affairs Department announced its policy not to issue submerged-lands permits solely for the purpose of dredging or mining coral or sand aggregate from the territory's coastal waters due to the potential adverse environmental impact on the shoreline.

Several studies were underway during the year to assess the potential for offshore sand extraction without an adverse environmental impact. In St. Croix, the Conservation and Cultural Affairs Department and the West Indies Laboratory of Fairleigh Dickinson University are cooperating in a program; and in St. Thomas, the department and the U.S. Geological Survey have a joint study. The investigations are divided into three parts and have as its goals to locate and define the composition of fine aggregate deposits on the insular shelf and determine the rate at which such deposition is taking place.[6]

Mineral production consists of basalt (traprock), which is crushed for use in concrete aggregate and roadstone. Caribbean Materials Supply Company and St. Croix Stone and Sand Company accounted for the total production. Traprock output declined 6% but the value increased 1% over that of 1976, reflecting a general stabilization in construction activity in the islands.

PACIFIC ISLAND POSSESSIONS[7]

American Samoa.—Production of crushed limestone for use in road building and concrete by the Department of Public Works dropped sharply from that of 1976. Output was only 5,925 tons, valued at $31,107 compared with $155,832 in 1976. The department also produced 1,313 tons of pumiceous material (volcanic cinder) valued at $10,000 for road building, also down from 1976 output of 46,725 tons valued at $29,662. Both of these quarry operations were near Pago Pago on Tutuila Island, the largest in the island group.

Guam.—Crushed limestone for use in roads, agricultural lime, and concrete was quarried by four operators (Hawaiian Rock

Products Co., Perez Brothers Inc., Pacific Rock Corp., and the government's Department of Public Works). The 1977 output of 576,768 tons valued at $1,896,705 was substantially higher than that of 1976 when 456,584 tons were produced valued at $1,437,849.

TRUST TERRITORY OF THE PACIFIC ISLANDS[8]

Palau Islands.—The proposed major port complex for the storage, refining, and transshipping of crude petroleum and refinery products to Japan remained controversial and was the subject of continuing study. In late 1976, the U.S. Department of the Interior, which administered these and other islands of the Pacific Islands Trust Territory, granted approval for a $3 million feasibility study, and the Palau Legislature asked the Department to fund an environmental impact study.

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[1] State Liaison Officer (Florida and Puerto Rico), Bureau of Mines, Tallahassee, FL.

[2] Adolphson, D. G., M. A. Seijo, and T. M. Robison. Water Resources of the Maunabo Valley, Puerto Rico. U.S. Geol. Survey Water Res. Inv. Rept. 76-115, 1977, 38 pp.

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[4] Jordan, D. G., and D. W. Fisher. Relation of Bulk Precipitation and Evapotranspiration to Water Quality and Water Resources, St. Thomas, Virgin Islands. U.S. Geol. Survey Water-Supply Paper 1663-I, 1977, 30 pp.

[5] Rock Products. V. 80, No. 6, June 1977, p. 26.

[6] Holmes, C. W. Virgin Islands Sand Resources Phase I (Preliminary). U.S. Geol. Survey, December 1977, 15 pp.

[7] Prepared by Walter C. Woodmansee, Supervisory Physical Scientist, International Data and Analysis.

[8] Prepared by Walter C. Woodmansee, Supervisory Physical Scientist, International Data and Analysis.

The Mineral Industry of Rhode Island

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior and the Rhode Island Department of Natural Resources for collecting information on all minerals except fuels.

By William R. Barton[1] and Carleton A. Maine[2]

The value of Rhode Island mineral products decreased 2% in 1977 according to data reported to the Federal Bureau of Mines. The decrease in value from $6.4 million in 1976 to $6.3 million in 1977 was a reflection of construction business indicators. Because sand and gravel and stone represent more than 99% of Rhode Island mineral production, mineral production data follows construction activity.

Rhode Island ranks 49th among the States in total value of mineral products. Production is limited to sand and gravel, stone, and recovery of gem and mineral specimens (gem stones) by dealers and collectors. Although ground limestone is produced, none of it is presently calcined into lime. Deposits of anthracite, clay, magnetite-ilmenite (iron and titanium ore), peat, and quartz (silica) are known to exist but are not worked at the present time. Some other minerals, most notably copper ore, were recovered sporadically in the past, but are not believed to have any present or future commercial value.

There are only about 5,000 pounds of new mineral materials produced per capita each year in Rhode Island. About 40,000 pounds of new mineral materials are required annually on a per capita basis to sustain the living standard of the average U.S. citizen. Rhode Island imports most of its mineral-derived needs, including all metals and mineral fuels. Despite the competitive disadvantages inherent in a lack of available indigenous mineral raw materials, the Rhode Island manufacturing industry has a substantial appetite for mineral industry products ranging from iron and steel to aluminum and abrasives. Among such industrial activities in the State are: Glass manufacture, metal plating and polishing, concrete products, jewelry, fiberglass, wire manufacturing, re-refining of precious and

Table 1.—Value of mineral production in Rhode Island, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Kent	$1,193	$1,576	Sand and gravel.
Newport	W	W	Stone, sand and gravel.
Providence	W	W	Sand and gravel, stone, gem stones.
Washington	1,872	1,804	Sand and gravel.
Undistributed	3,334	2,919	
Total	6,399	6,299	
Total 1967 constant dollars	3,285	^{p}3,109	

^{p}Preliminary. W Withheld to avoid disclosing company proprietary data; included in "Undistributed."
[1]Bristol County is not shown because no production was reported.

specialty metal and alloy scraps, chemicals, plastic and rubber, metal working and fabrication, machine tools and dies, electronic equipment, hardware, and tools. In addition, most construction activity is heavily dependent upon the use of mineral products.

A measure of the total significance of minerals and mineral products to the Rhode Island economy may be derived by studying the gross State product (GSP) figures issued annually by the Federal Reserve Bank of Boston. While mining represents only 0.1% of the GSP, construction is 4% and manufacturing is an additional 30%. The latter sector of the economy includes within its total: 18% stone, clay, glass, and primary and fabricated metal manufacture; 19% machinery, electrical and electronic items, motor vehicles, ordnance, and transport; and 10% chemicals, rubber, and plastics. All of these categories are largely dependent upon mineral-derived products. Even plastic, rubber, or organic chemical products may be more than 50% mineral filler or extender by weight in some cases.

Only about 320 of Rhode Island's 280,000 industrial workers are engaged in mining; however, 11,000 other persons work in mineral-dependent construction. Of those employed in manufacturing, the stone, clay, glass, primary metals, and fabricated metal products industries provide employment for 21,000. Other manufacturers that rely upon mineral-derived materials employ an additional 25,000 persons.

Minerals, and mineral-derived products, also provide employment in the transportation sector of the Rhode Island economy. Such items of commerce are not only important to the rail and truck transport industries, they are also contributing to the resurgence of traffic in the Port of Providence. For example, tonnage of steel unloaded doubled during the past fiscal year ending July 31, 1977. In the first half of the current fiscal year imports continued to post gains climbing 35% above those during the same period 1 year earlier. Of the freight traffic passing through the Port of Providence in 1977, 88% was mineral fuels and related products. Nonmetallic minerals and mineral products, metals and primary metal products, and metal scrap represented an additional 10% of the total port cargo tonnage. Thus, 98% of Providence waterborne commerce was directly related to the mineral, mineral product, and mineral fuel industries.

A statistical Memorandum of Understanding was promulgated between the Rhode Island Department of Natural Resources and the Federal Bureau of Mines for the first time. The two agencies will cooperate in the collection of mineral statistics and preparation of reports designed to disseminate mineral data analyses.

The Bureau of Mines was funding research into the extent and quality of Narragansett Basin anthracite reserves through Weston Observatory-Boston College and Charles River Associates. For fiscal year 1978, contracts of $240,000 and $48,000 were awarded to the two groups, respectively. Stress in the two studies was placed upon the legal, environmental, economic, and societal aspects that would be involved in any future anthracite development. The Bureau of Mines published a summary of in-house work to date concerning analytical and coal cleaning studies on the anthracite as Information Circular 8760, "Anthracite in the Narragansett Basin of Rhode Island and Massachusetts."

Etching and plating wastes from metalworking establishments were a difficult environmental and recycling problem in Rhode Island and other industrial States. Several Bureau of Mines research centers were working on improved methods for handling and reclaiming those and other industrial waste products. Bureau interest centered on wastes from facilities processing minerals or mineral-derived materials. State officials were invited to nominate most urgent waste problems as possible subjects for Bureau research efforts.

Rhode Island completed a plan for management of coastal lands and waters and submitted it for approval by the U.S. Department of Commerce. The plan affirmed a continuing moratorium upon mining in Rhode Island coastal waters and Coastal Resource Management Council (CRMC) authority to require CRMC approval for mining anywhere in Rhode Island. The approval of mining plans and regulation by CRMC were to be in addition to the required approvals by local zoning, planning, and conservation authorities.

Recycling of solid wastes was becoming an important program in Rhode Island as a result of a scarcity of land suitable for landfill use. A solid waste management and resource recovery authority was formed and Narragansett Electric Co. has conducted experiments at a Providence powerplant to mix powdered trash with the oil it normally burns.

Table 2.—Indicators of Rhode Island business activity

	1976	1977^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ---------- thousands--	434.0	440.0	+1.4
Unemployment ---------- do----	35.0	38.0	+8.6
Employment (nonagricultural):			
Mining ---------- do----	(1)	(1)	--
Manufacturing ---------- do----	122.9	127.6	+3.8
Contract construction ---------- do----	[2]11.9	[2]12.2	+2.5
Transportation and public utilities ---------- do----	13.3	13.3	--
Wholesale and retail trade ---------- do----	74.3	76.6	+3.1
Finance, insurance, real estate ---------- do----	18.2	19.2	+5.5
Services ---------- do----	69.1	71.6	+3.6
Government ---------- do----	57.0	58.2	+2.1
Total nonagricultural employment ---------- do----	366.7	378.7	+3.3
Personal income:			
Total ---------- millions--	$5,789	$6,332	+9.4
Per capita ----------	$6,187	$6,775	+9.5
Construction activity:			
Number of private and public residential units authorized ----------	4,572	5,301	+15.9
Value of nonresidential construction ---------- millions--	$56.6	$56.3	+11.3
Value of State road contract awards ---------- do----	$15.2	$16.0	+5.3
Shipments of portland and masonry cement to and within the State thousand short tons--	147	144	-2.0
Mineral production value:			
Total crude mineral value ---------- millions--	$6.4	$6.3	-1.6
Value per capita, resident population ----------	$7	$7	--
Value per square mile ----------	$5,272	$5,189	-1.6

^{p}Preliminary.

[1] Included with "Contract construction."

[2] Includes mining.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Table 3.—Worktime and injury experience in the Rhode Island mineral industry in 1977[1]

	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate	Nondisabling injuries	Nondisabling injury frequency rate
Sand and gravel:								
Surface------	195	281,499	--	--	2	7.10	1	3.55
Office-------	54	67,753	--	--	--	--	--	--
Total------	249	349,252	--	--	2	5.73	1	2.86
Stone:								
Surface------	40	35,411	--	--	--	--	--	--
Mill--------	18	33,475	--	--	--	--	1	29.87
Office-------	12	17,507	--	--	--	--	--	--
Total------	70	86,393	--	--	--	--	1	11.58
State total:								
Surface------	235	316,910	--	--	2	6.31	1	3.16
Mill--------	18	33,475	--	--	--	--	1	28.87
Office-------	66	85,260	--	--	--	--	--	--
Grand total--	319	435,645	--	--	2	4.59	2	4.59

[1] Data supplied by Mine Safety and Health Administration, U.S. Department of Labor.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland and masonry cement into Rhode Island from domestic producers was 139,000 tons and 5,000 tons respectively. These figures compared with 141,525 tons and 5,897 tons a year earlier. There are no cement producing plants in Rhode Island.

Gem Stones.—The value of gem stones and mineral specimens collected was estimated at a few thousand dollars in 1977.

Lime.—There was no lime production in Rhode Island in 1977, although ground limestone was produced at one locality.

Sand and Gravel.—There were 27 active sand and gravel operations in Rhode Island in 1977. The product was used principally in concrete, concrete products, asphalt paving, roadbase, and fill. Leading producers were: A. Cardi Construction Co., Inc; Rhode Island Sand and Gravel Co.; River Sand and Gravel Co.; South County Sand and Gravel Co.; and Tasca Sand and Gravel Co.

The urbanized character of Rhode Island has intensified pressure upon sand and gravel producers to locate deposits that are both economically viable to mine and culturally acceptable. The result was a continued upward trend in prices for mineral products used in construction.

Table 4.—Rhode Island: Construction sand and gravel sold or used by producers, by use

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	1,502	$2,259	$1.50	1,200	$2,232	$1.86
Gravel	1,413	2,548	1.80	1,673	2,828	1.69
Total[1]	2,914	4,805	1.65	2,872	5,059	1.76

[1]Data may not add to totals shown because of independent rounding.

Table 5.—Rhode Island: Construction sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	427	$842	$1.97	615	$1,294	$2.10
Concrete products (cement blocks, bricks, pipe, etc.)	681	1,112	1.63	363	726	2.00
Asphaltic concrete aggregates and other bituminous mixtures	506	1,111	2.20	588	1,240	2.11
Roadbase and coverings	671	859	1.28	630	1,074	1.71
Fill	517	631	1.22	676	726	1.07
Other uses	116	252	2.17	--	--	--
Total[1]	2,914	4,805	1.65	2,872	5,059	1.76

[1]Data may not add to totals shown because of independent rounding.

Stone.—Four companies produced stone in 1977. The Conklin Limestone Co., Inc., quarried and crushed marble at Ashton. The limestone was sold for rubble, agricultural limestone, terrazzo, roofing, filler, and flux purposes. M. A. Gammino Construction Co. produced granite at Cranston for use as bituminous and concrete aggregate, roadbase stone, riprap, railroad ballast, and filter stone. Peckham Brothers Co., Inc., crushed quartzitic graywacke near Middletown for macadam aggregate and roadbase use. Gerald T. Kidd, Inc., produced granite riprap.

A fire at the Providence Granite Co. destroyed the main office building and the powerplant for the granite cutting and finishing equipment housed in other buildings.

Table 6.—Rhode Island: Production of crushed stone,[1] by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Bituminous aggregate	90	W	108	W
Concrete aggregate	68	W	83	W
Dense-graded roadbase stone	35	W	21	W
Filter stone	20	W	10	W
Macadam aggregate	7	25	6	22
Railroad ballast	2	W	--	--
Other uses[2]	83	1,270	46	1,217
Total	305	1,295	274	[3]1,238

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes granite, limestone, and miscellaneous stone.

[2] Includes stone used in agricultural limestone, riprap, fill, roofing granules, flux stone, other filler, other uses, and uses indicated by symbol W.

[3] Data do not add to total shown because of independent rounding.

METALS

Selenium.—Wittenzellner Refining Co., formerly a wholly owned subsidiary of A. J. Oster Co., has been purchased by Selenium, Inc., a subsidiary of Refinemet International Co. Selenium, Inc., of Providence, plans to integrate the purchased operation with its own business of refining selenium residues and concentrates.

Steel.—Imports of steel through the Port of Providence have been increasing each year. In fiscal year 1977 such tonnage doubled over fiscal year 1976.

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[1] State Liaison Officer, Bureau of Mines, Newmarket, N.H.

[2] Assistant Director, Department of Environmental Management, Providence, R.I.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Sand and gravel:			
A. Cardi Construction Co., Inc	451 Arnold Rd. Coventry, RI 02816	Pit	Kent.
J. H. Lynch & Sons, Inc	Box 325 Ashton, RI 02864	Pit	Providence.
Material Services, Inc	Greenville Rd. North Smithfield, RI 02895	Pit	Do.
V. J. Paolino Construction Co.	Box 383 Slatersville, RI 02876	Pit	Do.
Rhode Island Sand & Gravel Co., Inc.	Kilvert St. Warwick, RI 02886	Pit	Kent.
River Sand & Gravel Co	221 Benedict St. Pawtucket, RI 02864	Pit	Washington.
South County Sand & Gravel Co., Inc.	North Rd. Peace Dale, RI 02878	Pit	Do.
Tasca Sand & Gravel Co	Box 113, RFD 4 Mann School Rd. Esmond, RI 02917	Pit	Providence.
Stone:			
Limestone, crushed:			
The Conklin Limestone Co., Inc.	R.F.D. 1 Lincoln, RI 02860	Quarry	Do.
Granite and other stone:			
M. A. Gammino Construction Co.	875 Phenix Ave. Cranston, RI 02920	do	Do.
Gerald T. Kidd, Inc	67 Riverside Dr. Tiverton, RI 02878	do	Newport.
Peckham Bros. Co., Inc	Box 193 Newport, RI 02840	do	Do.

The Mineral Industry of South Carolina

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey, State Development Board, for collecting information on all minerals except fuels.

By Hewson Lawrence[1]

The value of mineral production in South Carolina in 1977 continued the steady increase began in 1963 reaching a record high of $144.2 million. Compared with minerals produced in 1976, cement, vermiculite, peat, stone, and crude mica (sericite) production increased in both value and quantity. Sand and gravel and clays showed a production decrease while increasing in value, and fuller's earth production remained the same in quantity while increasing in value. Cement production continued to lead in dollar value as the principal mineral commodity in the State. Stone production continued to rank second in value to cement production followed by sand and gravel and clays. Asphalt, brick, and tile output was valued at approximately $90 million. Iron, steel, and ferroalloys production approached 750,000 tons and was valued at close to $200 million.

The production of kaolin and vermiculite in South Carolina continued to rank second nationally in quantity and value, and that of crude mica (sericite) ranked among the top producers both in quantity and value.

Table 1.—Mineral production in South Carolina[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays __________ thousand short tons__	2,270	$17,288	[2]2,172	[2]$18,705
Gem stones ______________________	NA	4	NA	4
Manganiferous ore__ thousand short tons__	9	W	20	W
Mica (scrap) _________________do____	W	W	43	589
Peat ______________________do____	15	W	16	W
Sand and gravel ______________do____	7,887	17,154	7,766	19,281
Stone ____________________do____	13,027	30,690	14,785	36,670
Combined value of cement, clays, (fuller's earth) vermiculite, and items indicated by symbol W ____________________	XX	[r]60,397	XX	68,952
Total ______________________	XX	[r]125,534	XX	144,201
Total 1967 constant dollars ________	XX	64,437	XX	[p]71,178

[p] Preliminary. [r] Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value." XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes fuller's earth; value included with "Combined value figure."

Table 2.—Value of mineral production in South Carolina, by county[1]

(Thousands)

County	1976[r]	1977	Minerals produced in 1977 in order of value
Aiken	$12,415	$14,366	Clays, sand and gravel.
Anderson	W	W	Stone, sand and gravel.
Bamberg	W	70	Sand and gravel.
Berkeley	W	3,184	Stone.
Charleston	136	606	Sand and gravel.
Cherokee	W	3,424	Stone, clays, sand and gravel, maganiferous ore, mica.
Chester	W	W	Sand and gravel.
Chesterfield	W	W	Sand and gravel, stone.
Clarendon	100	140	Sand and gravel.
Colleton	W	W	Sand and gravel, peat.
Darlington	W	--	
Dillon	W	84	Sand and gravel.
Dorchester	W	36,670	Cement, stone, clays, sand and gravel.
Edgefield	W	76	Clays.
Fairfield	W	W	Stone, sand and gravel.
Florence	327	1,028	Sand and gravel.
Georgetown	W	W	Stone, sand and gravel.
Greenville	W	W	Do.
Greenwood	W	W	Stone, sand and gravel, clays.
Horry	1,503	W	Sand and gravel, stone, clays.
Jasper	W	W	Sand and gravel.
Kershaw	W	W	Sand and gravel, clays, stone, mica.
Lancaster	W	W	Mica, clays, sand and gravel.
Laurens	W	W	Vermiculite, stone.
Lexington	W	W	Sand and gravel, stone, clays.
Marion	W	W	Clays, sand and gravel.
Marlboro	W	W	Sand and gravel, clays.
Newberry	W	32	Clays.
Oconee	159	163	Stone.
Orangeburg	26,135	29,251	Cement, stone, clays, sand and gravel.
Pickens	W	W	Stone.
Richland	W	W	Stone, clays, sand and gravel.
Saluda	16	6	Clays.
Spartanburg	W	W	Stone, sand and gravel.
Sumter	W	W	Sand and gravel, clays.
Union	26	W	Sand and gravel.
Williamsburg	W	--	
York	W	W	Stone, sand and gravel, clays.
Undistributed[2]	84,717	55,099	
Total	125,534	[3]144,201	

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Abbeville, Allendale, Barnwell, Beaufort, Calhoun, Hampton, Lee, and McCormick.

[2] Includes gem stones and values indicated by symbol W.

[3] Data do not add to total shown because of independent rounding.

Table 3.—Indicators of South Carolina business activity

	1976	1977^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	1,253.0	1,280.0	+2.1
Unemployment do	87.0	92.0	+5.7
Employment (nonagricultural):			
Mining do	1.8	1.8	--
Manufacturing do	371.0	379.9	+2.4
Contract construction do	61.5	65.9	+7.2
Transportation and public utilities do	42.7	45.2	+5.9
Wholesale and retail trade do	187.6	198.8	+6.0
Finance, insurance, real estate do	39.7	41.2	+3.8
Services do	130.5	133.9	+2.6
Government do	203.3	212.0	+4.3
Total nonagricultural employment do	1,038.1	1,078.7	+3.9
Personal income:			
Total millions	$14,781	$16,186	+9.5
Per capita	$5,197	$5,628	+8.3
Construction activity:			
Number of private and public residential units authorized	18,399	22,139	+20.3
Value of nonresidential construction millions	$128.4	$135.8	+5.8
Value of State road contract awards do	$114.4	$120.1	+5.0
Shipments of portland and masonry cement to and within the State thousand short tons	901	988	+9.7
Mineral production value:			
Total crude mineral value millions	$125.5	$144.2	+14.9
Value per capita, resident population	$44	$50	+13.6
Value per square mile	$4,040	$4,643	+14.9

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

In 1977, mineral commodities were produced by 120 separate companies, operating 230 mines located in 36 of the 46 counties of the State. Sand (including gravel and sand-clay mixture) was the leading commodity ranked by the number of operating mines (125), followed by miscellaneous clay (35), crushed stone (32), processed kaolin (11), and vermiculite (14).

Aiken County led in the number of operating mines (23), followed by Kershaw (14), and Cherokee and Lexington (13 each). No mineral production was reported in Abbeville, Allendale, Barnwell, Beaufort, Calhoun, Hampton, Lee, and McCormick.

Two South Carolina mining firms transferred ownership during 1977. SCA Services, Inc., purchased the fuller's earth operation in Sumter County from Bennett Minerals Co. Becker Sand & Gravel Co. is no longer a division of Gifford-Hill and Co., Inc.

Trends and Developments.—Sand and gravel production declined slightly owing to the continuing decrease in highway construction; however, the value increased 12% due partly to inflation and a general economic improvement toward the end of the year. Although the production of clays decreased slightly, value increased significantly largely because of a strengthening demand for brick. This trend is expected to continue through 1978. All other minerals (except fuller's earth) showed a significant increase in both production and value as the economy continued its recovery.

There was a trend toward conserving resources by recycling metals, glass, and paper at an accelerated rate. Several recycling centers were established at various locations throughout the State. The conservation of energy was another trend that is continuing at an increasing pace. The mineral processing industries, particularly brick manufacturers, were looking for ways to save energy by using new firing techniques and modernizing inefficient operations.

Prospecting within the State was highlighted by increased exploration for heavy minerals and phosphate rock in the flood plains, coastal wetlands, and the sea islands, and resulted in locating deposits that may, in some places, be in commercial quantities. Phosphorite averaging 6 feet in thickness lies at depths of up to 65 feet under most of Charleston, Berkeley, and Dorchester Counties, an area of 1,700 square miles. An estimated 2 million tons of heavy minerals, predominantly titanium oxides with small percentages of zircon and sillimanite, is contained in ancient beach sands in Charleston County. Heavy mineral deposits containing zirconium, thorium, and rare earths received continuing interest because of greatly increased use of rare earths in color television sets and miniaturized electronic equipment such as hand-held calculators.

Future production of aluminum ingots in South Carolina was assured with the announcement by Alumax, Inc., that a $400 million, primary-aluminum reduction plant will be built 20 miles north of Charleston on a 200-acre site. A planned capacity of 197,000 tons per year, with a payroll estimated at $12 million and employing approximately 800 persons, is expected by 1982. The site is near seaport facilities that will be needed for importing alumina (aluminum oxide) from Australia at the rate of one 30,000-ton shipload per month.

South Carolina's mineral output could greatly increase if the cost of bauxite from imported sources continues to rise. The high alumina content of the large kaolin deposits that exist within the State offer great potential for future use as a source of alumina. Current research by the Federal Bureau of Mines with industry cooperation verifies that alumina can be successfully extracted from clays. Data are being developed, from operation of a miniplant, to design a pilot demonstration plant for proving the engineering and economic feasibility on a production basis.

Samples of fuller's earth from a mine in Sumter County were analyzed for the South Carolina Geological Survey by the Bureau of Mines Tuscaloosa (Ala.) Metallurgy Research Center. The request for analysis was made because of continuing interest by several firms in using selected geologic formations for storage of chemical wastes. The challenge to geologists, hydrologists, and engineers in South Carolina is the application of scientific and engineering expertise to assure an environmentally safe repository for hazardous chemical wastes.

The Bureau awarded a grant to the South Carolina Land Resources Conservation Commission for "Monitoring of South Carolina Surface Mining Activities Using Digital Analysis of Landsat Imagery." The research project extends to other mining areas of work started by the South Carolina Liaison Office and members of the Commission in 1975 using selected kaolin mining areas in Aiken County. Digital analysis of Landsat data is progressing on mines in Cherokee, Horry, Laurens, and Spartanburg Counties, as well as additional mine locations in Aiken County. Mining activities are being located and classified, and mining and reclamation activity is being measured.

Legislation and Government Programs.—Under the South Carolina Mining Act of 1974, requiring each mining operation prior to mining to file for a permit including a reclamation plan, a total of 48 mining permit applications were received and 53 permits were issued for 1977.[2]

The Act requires that land mined after July 1, 1974, receive the greatest practical degree of protection and be reclaimed to a useful purpose. Mined areas are being reclaimed to the following uses:

Woodlands
Grasslands
Marshlands
Lake or pond
Park
Recreation
Residential.
Commercial.
Sanitary landfill.

Best management practices for mining are being used concurrently with mining operations or as soon as mining operations are completed. These include, but are not limited to, sediment basins, land smoothing, permanent vegetation, ponds, recreation, land grading and shaping, and tree planting. During 1975-76, mined land reclamation had progressed to the point where a nearly equal amount of land was being prepared and returned to multiphase use each year as that being opened for mining. For 1977, this ratio was not attained because of increased mining activity. A total of 280 acres have been reclaimed (released from bond) since the 1974 mining law was passed. During 1977, 230 acres were reclaimed and released. Reclamation in process consisted of 220 acres in woodlands, grasslands, or marshland; 9 acres in sanitary landfill; and development of 7 ponds for farms or recreation use. In addition, 260 acres were graded and will be planted into woodlands or grasslands.

The Dams and Reservoirs Safety Act was passed in 1977, requiring certain dams and reservoirs within the State to be certified and inspected "in the interest of public health, safety, and welfare in order to reduce the risks of failure of such dams; to prevent injuries to persons and damage to property." Water impoundments will be classified, and those that pose no downstream hazard will be declared exempt from further provisions of the act. If a downstream hazard does exist, a complete inspection of the dam's integrity will be made and a periodic inspection program developed. No mining ponds, settling basins, etc., were classified or inspected during 1977 under this act.

The mining and dams and reservoirs acts

are under the administration of the Regulatory Services Division of the South Carolina Land Resources Conservation Commission. The staff includes seven professionals and two support personnel. Additionally, a 32-member Technical Advisory Committee composed of various staff members from State and Federal agencies lend support to the division.

The Federal Water Pollution Control Act (Public Law 92-500) provides for the development and implementation of a Statewide management plan for the control and abatement of nonpoint source pollution resulting from mining activities. The South Carolina Land Resources Conservation Commission formed a subtask force composed of members from Federal and State agencies and the mining industry to assist in developing a plan. The report generated by this group concluded that provisions required by the State mining law before mining permits are issued insure that there will be no significant water pollution from active mines. Inactive mines are being inventoried to determine if water pollution problems exist with mined land that has not been returned to other productive use.

In response to the Coastal Zone Management Act of 1972 and amendments of 1976, a State act was signed into law in May 1977 to establish the South Carolina Coastal Council and provide for protection and improvement of coastal tidelands and wetlands under a Coastal Zone Management Plan. In September, the Council's permitting authority became effective within the four critical areas of the coastal zone — coastal waters, tidelands, beaches and primary ocean front sand dunes. A draft of final rules and regulations dealing with permits for alterations in critical areas of the coastal zone was published in October. A draft report designating geographic areas of particular concern was issued in November. The complete management plan for the State is expected to be available in draft form by the fall of 1978. The Bureau of Mines reviews the plan for compatibility with current mining operations and future mining potential.

The South Carolina Geological Survey, a division of the South Carolina State Development Board with a permanent, full-time State geologist and staff, observed its 20th consecutive year of geologic service to South Carolina. During 1977, more than 32 geological and geophysical field and laboratory investigations were continued, initiated, or participated in by Survey Division personnel.[3]

Some important projects initiated by the 6 full-time division geologists, 2 geologic technicians and 13 project geologists (mostly university faculty) are as follows:

1. Geologic Map of South Carolina.
2. Geology and Mineral Resources of Chesterfield County.
3. South Carolina Major Structures — determination of fault and fracture zones.
4. Earthquake History of South Carolina.
5. Aeromagnetic and Aeroradioactivity Mapping.
6. Facies Analysis of the South Carolina Coastal Plain.
7. The Atlantic Margin Coring Project (AMCOR) of the U.S. Geological Survey.
8. The Dutchman's Creek Gabbro Project.
9. The Geothermal (radiogenic heat flow) Project of the U.S. Department of Energy.

Geologic field and office assistance was provided to 40 different industrial prospects requesting data on 17 various mineral categories. Uranium, silica sand, and mineral resources (general) led the number of requests, followed by base metals, heavy minerals, limestone, kaolin, common clays, vermiculite, phosphate, peat, asbestos, gold and granite (both crushed and dimension).

Other requests included geologic information on oil and gas (potential, legislative status and related items) and subsurface materials storage and waste isolation.

Projects completed during 1977 and in preparation for publication were:

1. Geology of the Salem Quadrangle, by R. D. Hatcher, Jr.
2. Bibliography of South Carolina Geology, by A-J. W. Zupan.
3. Seismotectonic Map of Southeastern United States, by T. R. Visvanathan and D. E. Howell. Work so far indicates no relationship between earthquake epicenters and any known fault zone in South Carolina.

During 1977, the South Carolina Geological Survey released 12 new publications including 4 volumes of Geologic Notes containing 10 articles, a Catalog of Geologic Publications (2nd edition) and 4 open-file reports.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement production continued to rank first in value of mineral production. Both quantity and value were up substantially over that of 1976. Portland cements were produced by Giant Portland Cement Co. and Gifford-Hill Cement Co. in Dorchester County and Santee Portland Cement Co. in Orangeburg County. Giant and Santee also produced masonry cement. Each company, in addition to producing cement, mined marl and miscellaneous clays as raw materials in the manufacture of the cement. Approximately 90% of the portland cement produced was types I and II and was shipped to ready-mix companies, highway contractors, and concrete products manufacturers. Smaller amounts were sold to building material dealers and other contractors. Approximately 95% of the portland cement shipments was in bulk and the majority was transported by truck.

Clays.—Clay production in South Carolina is represented by producers of processed kaolin, miscellaneous clays used for the manufacture of brick and cement, and fuller's earth used as an absorbent. Total clay production (excluding fuller's earth) ranked fourth in value of mineral commodities produced in South Carolina and amounted to 2.17 million tons valued at $18.70 million.

South Carolina continued to rank second to Georgia in the production of kaolin in both quantity and value. Airfloated kaolin totaling 487,000 tons valued at $13.7 million was used principally in rubber products, fiber glass, animal feed and pet absorbent, adhesives, ceramics, pesticides, and fertilizers. Water-washed kaolin was produced by one company for paper coating.

Miscellaneous clays, including unprocessed kaolin and shale, were used mainly in the manufacture of common and face brick. Miscellaneous clay was produced from 35 mines in 17 counties. The leading producers of miscellaneous clays were Richtex Corp., Southern Brick Co., Giant Portland Cement Co., Gifford-Hill & Co., Inc., Palmetto Brick Co., Santee Portland Cement Corp., and Ashe Brick Co.

Merry Companies of Augusta, Ga., purchased a brick plant in Columbia from Guignard Brick Works and are converting it to burn sawdust instead of gas or oil. Wood products have lower ash and sulfur combustion products and cost at least one-third less than other energy sources.

According to data published by the U.S. Bureau of the Census in its monthly Current Industrial Report, Clay Construction Products, South Carolina continues to rank fifth in the production of brick (building or common and face). North Carolina, South Carolina, and Virginia comprise a regional marketing area which accounted for approximately 25% of the shipments of brick in 1977 in the United States.

Fuller's earth was produced at one mine in Sumter County and was sold chiefly for use as an absorbent in various oil and grease and pet products.

Table 4.—South Carolina: Kaolin sold or used by producers, by kind and use

(Short tons)

Kind and use	1976	1977
Airfloat:		
Adhesives	19,329	18,814
Animal feed and pet absorbent	28,542	23,410
Ceramics[1]	12,560	18,409
Fertilizers	9,150	12,170
Fiberglass	53,369	77,139
Paint	736	1,644
Paper filling	3,287	4,389
Pesticides and related products	25,136	16,181
Plastics	2,247	11,614
Rubber	215,941	237,377
Other refractories[2]	1,911	6,541
Other uses[3]	6,754	6,023
Exports[4]	66,919	55,256
Total	445,881	488,967
Unprocessed: Face brick; firebrick, block, and shapes; and high alumina refractories (1976)	177,341	234,568
Grand total	623,222	723,535

[1] Includes floor and wall tile (1976); pottery (1977); quarry tile (1977); roofing granules; sanitary ware; and miscellaneous.

[2] Includes high alumina refractories; refractory mortar and cement; foundry sand (1977); grogs and crudes; and miscellaneous.

[3] Includes common brick; crockery and other earthenware; drilling mud (1976); linoleum (1976); asphalt and roof tile; and ink.

[4] Includes ceramics; pesticides and related products; rubber; and miscellaneous.

Colemanite.—Industrial Minerals, Inc., York, processes colemanite (calcium borate) ore from Turkey in their Cherokee County plant. The ore is ground, dried, and shipped to PPG Industries, Inc., and Owens-Corning Fiberglas Corp. for use in textile fibers.

Feldspar.—Spartan Minerals Co., (a division of Lithium Corp. of America) produced a feldspar-silica mixture from tailings shipped to Pacolet from the Lithium Corp. spodumene operation in North Carolina. The feldspar-silica mixture was sold for use in glass containers, ceramic whiteware, and as a latex filler. No feldspar is currently being mined in South Carolina.

Manganiferous Ore.—Manganiferous schist, associated with the manganiferous member of the Battleground Schist of the Kings Mountain area, was mined in Cherokee County by brick manufacturers or contractors for use in coloring brick at South Carolina and North Carolina brick plants. Material from some pits has an average manganese content greater than 5% and less than 10% or possibly 15% at the most. The total quantity mined in 1977 was approximately 20,000 tons. The manganese content was estimated at 1,900 tons.

Mica (Sericite).—The Mineral Mining Corp. in Lancaster County mined and processed sericite by dry-milling sericite-rich ores and producing a micaceous product that was sold mainly for use in paint, expansion joint cement, and electronics. Although Mineral Mining Corp. is the only processor of the sericite-rich ores, numerous other deposits are mined by five companies for use in the manufacture of brick. Production of sericite increased in both quantity and in value from that of 1976 to 43,000 tons valued at $589,000. Prior to this year, production figures did not include the mineral used for brick manufacture. A comparison with 1975 (1976 data was withheld to avoid disclosure of company proprietary data) shows a sharp increase due in part to this added coverage.

Peat.—Crude peat was mined by dredging from a bog near Green Pond, Colleton County, by United States Peat Corp. and hauled to the company's processing and shipping plant at Green Pond. The crude peat is mixed with special additives for consumers to use in general soil improvement. Production increased by 1,000 tons to 16,000 tons. None is used for power generation.

Sand and Gravel.—Producers of sand and gravel in South Carolina include those companies that produce both commodities, those that produce only gravel, those that produce only sand, and also those producers of fill material, a product that contains a sand-clay mixture. Whether or not gravel is produced depends upon the location of the mining operation in the State, since most sand deposits do not contain any gravel-size components.

Total production of sand and gravel decreased slightly (1.5%) to 7.77 million tons but increased approximately 12% in value to $19.28 million. Sand and gravel ranked third in value of mineral commodities produced in South Carolina. Most of this production is from "sand only" operations. Construction sand and gravel was used primarily for concrete aggregate, asphaltic concrete, fill, and concrete products. Industrial sand was sold for use in glassmaking, chemicals, blast, porcelain and tile, foundry and filtration. Most sand and gravel was shipped by truck.

During 1977, 4 new sand and 13 new sand-clay mining operations were begun.[4] During the same period, three sand mines were deactivated.

Pennsylvania Glass Sand Corp. in Lexington County mined and processed a high-quality silica sand for use in the glass, fiber glass, ceramic, and chemical industries in the Southeast. Wedron Silica Div., Del Monte Properties Co. in Kershaw County processed silica sand for glassmaking from a pit operated by Whitehead Brothers Co.

Aiken County has the most operating mines (12), followed by Charleston (11), and Lexington (9). However, according to total quantity of production reported, Lexington was the leading county, followed by Sumter, Chesterfield, Florence, Lancaster and Marlboro.

Table 5.—South Carolina: Sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	5,563	$8,727	$1.57
Gravel	1,314	4,096	3.12
Total or average	6,877	12,823	1.86
Industrial sand	888	6,458	7.27
Grand total or average	[1]7,766	19,281	2.48

[1] Data do not add to total shown because of independent rounding.

Table 6.—South Carolina: Sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	2,709	$5,942	$2.19
Concrete products	473	995	2.10
Asphaltic concrete	1,525	3,126	2.05
Roadbase and coverings	381	646	1.70
Fill	1,193	1,330	1.11
Railroad ballast[1]	W	W	1.00
Other uses	574	763	1.33
Total or average	6,877	12,823	1.86

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Railroad ballast included in "Total."

Stone.—The value of stone production continued to rank second behind cement production in the State. Crushed stone output expanded 14% in quantity to 14.77 million short tons and increased 21% in value to $36.04 million. Crushed stone was produced at 32 quarries by 16 companies in 18 counties. Richland, Dorchester, Pickens, Lexington, Fairfield, Berkeley and Spartanburg Counties each produced over 1 million tons. Most of the stone mined was granite. Several companies produced limestone (including coquina) and a few companies mined marl. No shell limestone was produced during 1977. Vulcan Materials Co., Martin Marietta Corp., and Lone Star Industries were the leading producers.

Crushed granite was used for roadstone, dense-graded roadbase, concrete aggregate, bituminous aggregate, agricultural limestone, macadam aggregate, railroad ballast, and riprap. Most of the crushed granite was shipped by truck.

Crushed limestone and coquina were used primarily for roadbase stone, agricultural limestone, and concrete and bituminous aggregate.

Crushed marl produced by three cement companies was used in the manufacture of portland cement.

Dimension granite was produced by Granite Quarry Corp., Winnsboro Granite Corp., and Comolli Granite Co. from five quarries in Fairfield and Kershaw Counties for use in monumental stone and rough blocks. Output declined 22% to 13,160 tons valued at $627,000.

Among all the States, South Carolina led in output of marl and ranked fourth in output of crushed granite.

Table 7.—South Carolina: Crushed stone,[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	730	1,853	3,623	8,806
Roadstone	3,892	10,030	3,059	7,986
Concrete aggregate	2,349	5,929	2,794	7,660
Cement manufacture	2,201	2,624	2,198	2,621
Bituminous aggregate	1,488	3,707	1,603	4,125
Agricultural limestone	W	W	487	2,138
Macadam aggregate	1,416	2,796	407	1,078
Railroad ballast	267	732	332	859
Riprap and jetty stone	96	247	W	W
Other uses[2]	571	1,875	268	770
Total[3]	13,010	29,790	14,772	36,043

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, marl, granite, and shell (1976 only).

[2] Includes surface treatment aggregate, unspecified uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Vermiculite.—Production of crude vermiculite increased 19% in quantity (compared with a decrease in 1976 of 24%) and 36% in value. Exfoliated vermiculite sold or used increased substantially in both quantity and value. Crude vermiculite was mined by W. R. Grace & Co. from four mines in Laurens County and from seven mines in Spartanburg County. The ore was exfoliated at two plants, one each in Greenville and Laurens Counties. Patterson Vermiculite Co. mined crude vermiculite from three mines in Laurens County and exfoliated the ore in a plant in the same county. Principal uses of exfoliated vermiculite are for soil conditioning additives, for manufacture of lightweight aggregates (concrete, plaster, and fireproofing), and in loose and block insulation. Crude vermiculite production in South Carolina is second to that of Montana.

Zircon.—Milled zircon (zirconium silicate) was produced by M & T Chemicals, Inc., in Georgetown County using raw materials obtained from Florida, Georgia, and Australia. Zircon concentrates are processed by fine grinding (dry and wet with chemicals added) and shipped for foundry, wall tile, whiteware, and general ceramic uses.

METALS

No metals were mined in South Carolina in 1976. Minerals formerly mined included gold, tin, lead, manganese, and copper. However, iron, steel, and ferroalloys production from ores obtained from out-of-State sources is estimated at 750,000 tons with a value close to $200 million. Other basic minerals consumed but not produced in the State include copper, aluminum, uranium, and phosphate.

Ferroalloys.—Special ferroalloys were produced by Airco Alloys in Charleston using ore which, over the years, has come from the U.S.S.R., Turkey, Southern Rhodesia, the Republic of South Africa, India, Iran, Albania, and several other countries. The ore supplies have been steadily decreasing as problems continue in Southern Rhodesia and develop in the Republic of South Africa. Monthly production of major ferroalloys totaled approximately 10,000 long tons from processing some 30,000 long tons of ore.

Iron and Steel.—Steel was produced in Georgetown by the Georgetown Steel Co., a subsidiary of Korf Industries of West Germany. Raw material for steel manufacture was in the form of prereduced pellets made by the Midrex process. This steel plant is one of two U.S. plants that currently use this process, which allows a high quality of steel to be produced in electric arc furnaces without coke ovens or blast furnaces. Georgetown Steel Co. has become the Nation's second largest producer of wire rod. Owen Electric Steel and Nucor Steel utilized iron and steel scrap for producing a variety of products.

MINERAL FUELS

There was no production of mineral fuels in South Carolina during 1977.

Power Generation.—The consumption of coal to generate power exceeded 6,455,000 tons during 1977 and represented approximately 38% of the fuel used for thermal electricity generation. Natural gas accounted for approximately 1%, oil for approximately 9%, nuclear approximately 44%, and hydroelectric power approximately 8% of the total power generated.

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[1] State Liaison Officer, Bureau of Mines, Columbia, S.C.

[2] Report, South Carolina Mining and Reclamation Division.

[3] Olson, N. K. Geologic Activities in South Carolina during 1977. Geologic Notes (Geological Survey, South Carolina State Development Board), v. 22, No. 1, 1978.

[4] Data courtesy of Department of Mining and Reclamation, South Carolina Land Resources Conservation Commission published in Geologic Notes, (Geological Survey, South Carolina State Development Board), v. 22, No. 1, 1978.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Giant Portland Cement Co	Box 218 Harleyville, SC 29448	Plant	Dorchester.
Gifford-Hill & Co., Inc	Box 326 Harleyville, SC 29448	do	Do.
Santee Portland Cement Corp	Box 698 Holly Hill, SC 29059	do	Orangeburg.
Clays:			
Common clay and shale:			
Giant Portland Cement Co	Box 218 Harleyville, SC 29448	Mine	Dorchester.
Gifford-Hill & Co., Inc	Box 326 Harleyville, SC 29448	do	Orangeburg.
Palmetto Brick Co	Box 430 Cheraw, SC 29520	do	Kershaw and Marlboro.
Richtex Corp	Box 3307 Columbia, SC 29230	do	Lexington and Richland.
Santee Portland Cement Corp	Box 698 Holly Hill, SC 29059	do	Orangeburg.
Southern Brick Co	Box 208 Ninety Six, SC 29666	do	Greenwood, Newberry, Saluda.
Fuller's earth:			
SCA Services, Inc	Box 158 Pinewood, SC 29125	Mine and plant	Sumter.
Kaolin, processed:			
Dixie Clay Co	Box B Bath, SC 29816	do	Aiken.
J. M. Huber Corp	Box 306 Langley, SC 29834	do	Do.
Colemanite:			
Industrial Minerals, Inc	Box 459 York, SC 29745	Plant	Cherokee.
Feldspar, crude:			
Spartan Minerals Co., a div. of Lithium Corp. of America.	Box 520 Pacolet, SC 29372	do	Spartanburg.
Manganiferous ore:			
Broad River Brick Co., Div. of Boren Clay Products.	Box 550 Gaffney, SC 29340	Mine	Cherokee.
Mica, crude (sericite):			
Mineral Mining Corp	Box 458 Kershaw, SC 29067	Mine and plant	Lancaster.
Peat:			
United States Peat Corp	Box 245 Green Pond, SC 29446	Bog and plant	Colleton.
Sand and gravel:			
Addco Mining Co	4142 Dorchester Rd. Charleston, SC 29405	Pit and plant	Charleston and Dorchester.
Asphalt Products Corp	Route 2 Lancaster, SC 29720	do	Chesterfield, Darlington, Florence, Georgetown, Horry, Sumter.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel: —Continued			
Becker Sand & Gravel Co	Box 848 Cheraw, SC 29520	Pit and plant	Marlboro, Sumter, Colleton, Chesterfield, Florence.
Dickerson, Inc	Box 400 Monroe, NC 28110	do	Chester, Chesterfield, Lancaster, York.
Foster-Dixiana Sand Co	Box 5447 Columbia, SC 29250	do	Lexington.
Lone Star Industries	Box 5185 Columbia, SC 29205	do	Richland.
McDaniels Sand & Gravel Co., Inc	Box 497 Andrews, SC 29510	do	Georgetown and Williamsburg.
Metromont Sand Corp., Div. Metromont Materials Corp.	Box 1292 Spartanburg, SC 29304	do	Cherokee, Greenville, Spartanburg.
Pennsylvania Glass Sand Corp	Box 84 Cayce, SC 29033	do	Lexington.
Stone:			
Granite, crushed and broken:			
Lone Star Industries, Inc	Box 5185 Columbia, SC 29205	Quarry and plant	Fairfield, Greenwood, Laurens, Richland.
Martin Marietta Corp	Box 1758 Columbia, SC 29202	do	Fairfield, Lexington, Richland, York.
Vulcan Materials Co	Box 188 Blacksburg, SC 29702	do	Cherokee, Greenville, Laurens, Pickens, Spartanburg.
Granite, dimension:			
Comolli Granite Co	RFD 2, Box 297 Kershaw, SC 29067	Quarry	Kershaw.
Granite Quarry Corp., Div. of Matthews Inter Corp.	Rt. 2 Kershaw, SC 29067	do	Do.
The Winnsboro Granite Corp	Rion, SC 29132	do	Fairfield.
Limestene, crushed:			
Martin Marietta Corp	Box 1758 Columbia, SC 29202	Quarry and plant	Georgetown.
Vulcan Materials Co	Box 188 Blacksburg, SC 29702	do	Cherokee.
Marl, crushed:			
Giant Portland Cement Co	Box 218 Harleyville, SC 29448	Pit	Dorchester.
Gifford-Hill & Co., Inc	Box 326 Harleyville, SC 29448	Pit	Do.
Santee Portland Cement Co	Box 698 Holly Hill, SC 29059	Pit	Orangeburg.
Coquina (shell limestone), crushed:			
Cedar Creek Village, Div. of Waccamaw Construction Co.	Box 3525 North Myrtle Beach, SC 29582	Quarry	Horry.
Martin Marietta Corp	Box 1758 Columbia, SC 29202	Quarry and plant	Georgetown.
Vermiculite, crude and exfoliated:			
W. R. Grace & Co	Rt. 1 Enoree, SC 29335	Mine and plant	Greenville, Laurens, Spartanburg.
Patterson Vermiculite Co	do	do	Laurens.

The Mineral Industry of South Dakota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the South Dakota State Geological Survey for collecting information on all minerals.

By James H. Aase[1]

The value of mineral production in South Dakota for 1977 reached a new alltime high of $110.1 million, a 9% increase compared with the 1976 value, and $7.9 million greater than the former high record value set in 1974. Metals accounted for 41%, nonmetals 52%, and fossil fuels 7% of the total 1977 mineral output value. Gold was the State's leading mineral commodity in terms of value, followed in order by cement, stone, sand and gravel, petroleum, lime, and bentonite.

Nationally, South Dakota ranked second behind Nevada in gold production for the year, with the Homestake mine at Lead accounting for the bulk of the total State output. Minor amounts of gold were produced from small placer operations. Although the quantity of gold produced decreased about 4% from the 1976 output, the value of 1977 production was 13% higher owing to major advances in gold prices; the average price rose about $23 to $148 per troy ounce.

Table 1.—Mineral production in South Dakota[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] ---- thousand short tons	124	$137	197	$233
Gem stones	NA	44	NA	40
Gold (recoverable content of ores, etc.) ---- troy ounces	318,511	39,916	304,846	45,212
Mica, scrap ---- short tons	--	--	56	5
Petroleum (crude) ---- thousand 42-gallon barrels	447	5,519	632	7,584
Sand and gravel ---- thousand short tons	5,763	8,057	6,043	9,815
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	58	253	69	317
Stone ---- thousand short tons	3,241	17,240	3,412	18,881
Combined value of beryllium concentrate (1976), cement (masonry and portland), clays (bentonite), feldspar, gypsum, iron ore, lime, mica (scrap, 1977), and natural gas liquids	XX	30,364	XX	28,653
Total	XX	101,530	XX	110,740
Total 1967 constant dollars	XX	52,115	XX	^{p}54,661

^{p}Preliminary. NA Not available. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes bentonite; value included in "Combined value" figure.

Table 2.—Value of mineral production in South Dakota, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Aurora	$15	$35	Sand and gravel.
Beadle	--	23	Do.
Bon Homme	15	50	Do.
Brookings	375	825	Do.
Brown	298	221	Do.
Butte	W	W	Clays, sand and gravel.
Campbell	57	100	Sand and gravel.
Charles Mix	139	236	Do.
Clark	79	83	Do.
Clay	W	24	Do.
Codington	W	W	Do.
Corson	21	55	Do.
Custer	W	W	Stone, feldspar, sand and gravel.
Davison	28	62	Sand and gravel.
Day	57	113	Do.
Deuel	165	83	Do.
Dewey	W	54	Do.
Douglas	W	W	Do.
Fall River	W	W	Sand and gravel, stone.
Faulk	30	100	Sand and gravel.
Grant	W	W	Stone, sand and gravel.
Gregory	77	216	Sand and gravel.
Haakon	9	18	Do.
Hamlin	28	52	Do.
Hand	W	W	Do.
Hanson	W	W	Stone, sand and gravel.
Harding	W	--	
Hutchinson	63	99	Sand and gravel.
Hyde	60	114	Do.
Jerauld	24	109	Do.
Jones	6	59	Do.
Kingsbury	15	22	Do.
Lake	W	W	Do.
Lawrence	W	W	Gold, silver, sand and gravel, stone.
Lincoln	82	105	Sand and gravel.
Lyman	96	42	Do.
McCook	--	W	Do.
McPherson	--	134	Do.
Marshall	W	W	Do.
Meade	W	W	Sand and gravel, gypsum.
Miner	--	35	Sand and gravel.
Minnehaha	W	W	Stone, sand and gravel.
Moody	99	178	Sand and gravel.
Pennington	28,550	30,518	Cement, stone, lime, sand and gravel, clays, mica, beryllium.
Perkins	334	W	Sand and gravel.
Potter	28	60	Do.
Roberts	412	W	Do.
Sanborn	4	--	
Spink	W	149	Sand and gravel.
Sully	30	42	Do.
Tripp	W	42	Stone.
Union	60	64	Sand and gravel.
Walworth	W	W	Do.
Yankton	W	W	Sand and gravel, stone.
Ziebach	W	W	Sand and gravel.
Undistributed[2]	70,271	76,621	
Total[3]	101,530	110,740	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Bennett, Brule, Buffalo, Edmunds, Hughes, Jackson, Mellette, Shannon, Stanley, Todd, Turner, and Washabaugh.

[2] Includes gem stones, some sand and gravel, petroleum, and natural gas liquids that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of South Dakota business activity

		1976	1977	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	311.0	317.0	+1.9
Unemployment	do	11.0	10.0	-9.1
Employment (nonagricultural):				
Mining	do	2.5	--	--
Manufacturing	do	22.2	--	--
Contract construction	do	11.1	--	--
Transportation and public utilities	do	12.1	--	--
Wholesale and retail trade	do	60.6	--	--
Finance, insurance, real estate	do	9.5	--	--
Services	do	44.7	--	--
Government	do	55.9	--	--
Total nonagricultural employment	do	218.6	--	--
Personal income:				
Total	millions	$3,494	$4,104	+17.5
Per capita		$5,097	$5,957	+16.9
Construction activity:				
Number of private and public residential units authorized		4,777	5,983	+25.2
Value of nonresidential construction	millions	$51.3	$77.1	+50.3
Value of State road contract awards	do	$39.7	$45.0	+13.3
Shipments of portland and masonry cement to and within the State	thousand short tons	383	380	-.8
Mineral production value:				
Total crude mineral value	millions	$101.5	$110.7	+9.1
Value per capita, resident population		$148	$161	+8.8
Value per square mile		$1,318	$1,437	+9.0

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

The mineral production and processing base of the State was increased by the addition of two new mining operations and the expansion of a mineral processing facility. The Sequoya Granite Co. began quarrying operations in Grant County for the production of monument and ornamental stone. In Lawrence County, the Alpine-Strawberry Mining Co. started operations to recover gold from placer material, utilizing a processing plant built around a 180-ton dredge that had been removed from the water and put on land. The State-owned cement plant in Rapid City, the largest mineral processing facility in the State, expanded its production capacity from 3 to 6 million barrels annually. The $36 million expansion project, completed during the year, included the changeover to coal from natural gas as the processing fuel and a new dry-process system to manufacture the cement.

Homestake Mining Co. completed work on a project to prevent mine tailings and waste discharges, generated at its gold mining operations at Lead, from entering the area's freshwater streams. The $14.2 million project entailed the construction of a tailings dam and impoundment basin, slurry pumping plant, waste water treatment plant, water recycling works, and pipeline and related facilities.

Exploration activities continued at a rapid pace for uranium and oil and gas during the year. Uranium exploration was carried out by 11 operators, drilling several thousand test holes totaling about 500,000 feet. Principal areas in which the uranium exploration was conducted included Fall River, Custer, Lawrence, Meade, Butte, Harding, Perkins, and Corson Counties.

In 1977, South Dakota experienced its third most active year in the number of exploration test wells drilled for oil and gas. Fifty-three test wells were drilled, of which 35 resulted in producers, 6 were new discovery wells, and 29 were field development wells. One of the new discovery wells, located in southwestern Harding County, tested at about 1 million cubic feet per day of natural gas, and it seems likely that a commercial gas field exists, which would be the first for the State.

Production of petroleum (crude) was a record high in 1977, increasing 41% in quantity and 37% in value over 1976 levels. Output in 1977 was obtained from 69 wells in 13 fields, compared with 43 wells in 12 fields during 1976.

South Dakota's mineral industry was responsible for sizable amounts of revenue that accrued to State government. State income derived from the sale of mineral leases, royalty and rental payments, mineral production tax, and other mineral-related sources was approximately $1.8 million in 1977. Other contributions of the State's mineral industry to South Dakota's economy are estimated conservatively at $58 million annually in the form of payroll, goods and services, and other income, from the nearly 3,000 primary jobs involved. The number of secondary jobs and indirect income produced are estimated to be 2-1/2 times these figures.

In 1977 the South Dakota State Legislature passed a number of bills affecting the State's mineral industry. Included in the measures enacted into law were a 3% gross profit tax on oil and gas production and the requirement that all new energy transmission and conversion facilities have a permit from the State Public Utilities Commission and that the company requesting the permit provide a 10-year forecast of development plans.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Production of cement in 1977 was 8% lower in quantity and 4% higher in value compared with the 1976 output. The State-owned cement plant in Rapid City accounted for all the production. The disposition of finished portland cement shipments was 71% to ready-mix companies, 11% to highway contractors, 10% to concrete product manufacturers, 5% to building material dealers, and the remainder to various other customers.

Clays.—Clay production in 1977 declined 7% in quantity and 49% in value compared with the 1976 figures. Bentonite accounted for the largest part of the value of clays produced. Principal uses for the bentonite were in foundry sands, animal feed, drilling muds, and waterproofing sealants. Common clay and shale was produced for use in cement manufacturing, lightweight aggregate, and brickmaking.

Feldspar.—Production of crude feldspar in 1977 was 18% lower in quantity and 24% higher in value compared with 1976 levels. Production came from mines located in Custer County. Pacer Corp., operators of a grinding mill at Custer, processed the bulk of the crude feldspar output.

Gem Stones.—All the gem stone material produced in South Dakota, estimated at a value of $40,000 in 1977, results from the recreational activities of mineral collectors and other hobbyists. Mineral specimens and gem materials occur in a wide variety of geological environments in the State. The most important occurrence is in the pegmatite deposits of the Black Hills. A second type is in sedimentary rock where circulating ground water has deposited or recrystallized many mineral species in various forms. Other occurrences are in metamorphic rocks, veins, alluvial deposits, and gossans. Bulletin 18 of the South Dakota School of Mines and Technology by Roberts and Rapp entitled "Mineralogy of the Black Hills" describes all mineral species found in western South Dakota, lists all mines and mineral locations, and provides a complete bibliography.

Gypsum.—Total State production of gypsum in 1977 came from a mine in Meade County operated by the South Dakota Cement Commission. All the gypsum output was used in cement manufacturing. Production of gypsum in 1977 increased 12% in quantity and over 200% in value, compared with that of 1976.

Lime.—Output of lime in 1977 increased 4% in quantity and 11% in value compared with 1976 output. All production came from the Pete Lein & Sons, Inc., plant in Rapid City.

Mica.—A small amount of mica was produced at a mine in Pennington County operated by the Pendleton Mining Co.

Sand and Gravel.—Sand and gravel production in 1977 increased 5% in quantity and 22% in value compared with 1976 levels. Output totaling 6 million tons was produced from 124 operations located in 52 counties during 1977. Minnehaha County led in production, followed by Brookings, Pennington, Yankton, Fall River, Butte, and Codington Counties, which together accounted for 43% of the State total. Approximately 34% of the State's entire output was used for roadbase and coverings, 26% for fill, 20% for concrete aggregate, 15% for asphaltic concrete, 3% for concrete products, and the remainder for railroad ballast and other uses.

Table 4.—South Dakota: Construction sand and gravel sold or used by producers, in 1977

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	1,358	$2,352	$1.73
Gravel	4,685	7,463	1.59
Total or average	6,043	9,815	1.62

Table 5.—South Dakota: Construction sand and gravel sold or used in 1977, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	1,219	$2,611	$2.14
Concrete products	208	476	2.29
Asphaltic concrete	909	1,521	1.67
Roadbase and coverings	2,046	3,379	1.65
Fill	1,593	1,747	1.10
Railroad ballast	1	4	3.00
Other	67	78	1.16
Total or average	6,043	[1]9,815	1.62

[1] Data do not add to total shown because of independent rounding.

Stone.—Stone production consisting of limestone, sandstone, and granite was produced from 20 quarries in nine counties. Output in 1977 increased 5% in quantity and 10% in value compared with that of 1976.

Dimension granite, produced by five companies operating seven quarries in Grant County, accounted for 60% of the total value of stone produced in the State during 1977. The principal usage was for monumental purposes.

Crushed and broken stone, used principally for concrete and bituminous aggregate, cement and lime manufacturing, railroad ballast, and roadbed material, accounted for 99% of the total output quantity.

Table 6.—South Dakota: Stone sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Kind of stone	1976		1977	
	Quantity	Value	Quantity	Value
Dimension stone total[1]	37	10,653	35	11,404
Crushed and broken:				
Limestone	2,228	3,788	2,276	4,249
Other stone[2]	976	2,799	1,101	3,228
Total[3]	3,241	17,240	3,412	18,881

[1] Data represent granite.
[2] Data include sandstone and granite (1977).
[3] Data may not add to totals shown because of independent rounding.

Table 7.—South Dakota: Stone sold or used by producers, by use

(Thousand short tons and thousand dollars, unless otherwise specified)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough monumental[1] thousand cubic feet	207	3,103	208	3,956
Dressed monumental do	202	7,550	188	7,448
Total thousand short tons	37	10,653	35	11,404
Crushed and broken stone:				
Bituminous aggregate	288	713	314	818
Concrete aggregate	916	2,341	1,403	3,487
Macadam aggregate	W	W	2	3
Other construction aggregate and roadstone	138	271	113	140
Surface treatment aggregate	68	140	53	121
Railroad ballast	328	815	333	868
Riprap and jetty stone	92	232	38	97
Other uses[2]	1,375	2,075	1,120	1,945
Total	3,204	6,587	3,377	7,477
Grand total[3]	3,241	17,240	3,412	18,881

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes rough architectural and dressed architectural stone.

[2] Includes stone used for agricultural limestone, dense-graded roadbase stone, cement and lime manufacture, and uses not specified or indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

METALS

Gold.—Production of gold in 1977 decreased 4% in quantity and increased 13% in value compared with 1976 levels. Homestake Mining Co.'s lode mine at Lead provided the bulk of the production, with minor amounts coming from the Maurice Hoffman Co. placer mine operation in Lawrence County.

The average recovery grade of the lode mine ore processed was approximately 0.19 ounce per ton of gold content, and that of the placer ore was approximately 0.03 ounce per cubic yard of material washed.

Silver.—Production of silver in 1977 increased 19% in quantity and 25% in value compared with the previous year. The silver was obtained as a coproduct along with gold produced at the Homestake Mine in Lead.

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[1] State Liaison Officer, Bureau of Mines, Bismarck, N. Dak.

Table 8.—South Dakota: Mine production (recoverable) of lode gold and silver

	1975	1976	1977
Mines producing: Lode	1	1	1
Material sold or treated: Gold ore thousand short tons	1,473	1,658	1,578
Production:			
Quantity:			
Gold troy ounces	304,935	318,511	304,846
Silver do	67,669	58,117	68,717
Value:			
Gold thousands	$49,244	$39,916	$45,212
Silver do	299	253	317
Total do	49,543	40,169	45,529

Table 9.—South Dakota: Homestake mine ore milled and receipts for gold produced

Year	Ore milled (thousand short tons)	Receipts for gold produced	
		Total (thousands)	Per ton
1973	1,574	$34,974	$22.22
1974	1,560	54,906	35.20
1975	1,473	49,244	33.43
1976	1,658	39,916	24.07
1977	1,578	45,212	28.65

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Cement: South Dakota Cement Commission.	Box 360 Rapid City, SD 57701	Wet-process, 3-rotary-kiln plant.	Pennington.
Clays:			
American Colloid Co	Box 160 Belle Forche, SD 57717	Open pit mine and plant	Butte.
Black Hills Clay Products Co	Box 428 Belle Forche, SD 57717	Open pit mine and brick plant.	Do.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57701	Open pit mine and plant	Pennington.
Feldspar: Pacer Corp	Box 311 Custer, SD 57730	Open pit mines and dry-grinding plant.	Custer.
Gold: Homestake Mining Co	Box 875 Lead, SD 57754	Underground mine, cyanidation mill, and refinery.	Lawrence.
Gypsum: South Dakota Cement Commission.	Box 360 Rapid City, SD 57701	Open pit mines	Meade.
Lime:			
Pete Lien & Sons, Inc	Box 3124 Rapid City, SD 57701	1-rotary-kiln, 1-vertical-kiln, continuous-hydrator plant.	Pennington.
Sand and gravel (commercial):			
W. E. Bartholow & Sons Construction.	Box 3 Huron, SD 57350	Pit	Various.
Albert Bielke	Aberdeen, SD 57401	Pit and plant	Brown.
Birdsall Sand and Gravel Co., Inc.	Box 767 Rapid City, SD 57701	do	Fall River and Pennington.
Concrete Materials Co	100 South Dakota Ave. Sioux Falls, SD 57102	Pits	Minnehaha and Roberts.
Duinick Brothers Construction.	Olivia, MN 56277	Pit and plant	Pennington.
L. G. Everist, Inc	302 Paulton Bldg. Sioux Falls, SD 57102	do	Various.
Fischer Sand and Gravel	Box 1034 Dickinson, ND 58601	do	Lawrence.
Fodness Gravel	Route 5 Sioux Falls, SD 57701	do	Minnehaha.
Hallett Construction Co	Box 90 St. Peter, MN 56082	do	Codington.
Highway Construction Co	Box 511 Rapid City, SD 57701	Pit	Pennington.
Mannerud, Inc	Box 223 Brookings, SD 57006	Plant	Brookings.
F. J. McLaughlin Co	Box 13 Watertown, SD 57201	Pit	Codington.
N & M Construction, Inc	Box 337 Sturgis, SD 57785	Pit	Meade.
Reynolds Construction Co	Box 689 Sioux Falls, SD 57101	Pits	Minnehaha.
Weelborg Brothers, Inc	Dell Rapids, SD 57022	Pits and mill	Various.
Silver: Homestake Mining Co	Box 875, Lead, SD 57754	*See* gold	Lawrence.
Stone:			
Cold Spring Granite Co	Cold Spring, MN 56320	2 quarries	Grant.
Concrete Materials Co	100 South Dakota Ave. Sioux Falls, SD 57102	Quarry and plant	Minnehaha.
Dakota Granite Co	Box 269 Milbank, SD 57252	2 quarries	Grant.
Delano Granite Works, Inc	Delano, MN 55328	Quarry	Do.
L. G. Everist, Inc	302 Paulton Bldg. Sioux Falls, SD 57102	Quarry and plant	Minnehaha and Pennington.
Hills Materials Co	Box 1392 Rapid City, SD 57701	do	Pennington.
Robert Hunter Granite Co., Inc.	501 East Drake St. Milbank, SD 57252	Quarry	Grant.
Pete Lien & Sons, Inc	Box 3124 Rapid City, SD 57701	Quarry and plant	Pennington.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Sequoya Granite Co	Box 1033 Milbank, SD 57252	Quarry	Grant.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57701	Quarry and plant	Pennington.
Spencer Quarries, Inc	Spencer, SD 57374	Quarry	Hanson.
Steiner-Rausch Granite Co	Route 2, Box 36 Ortonville, MN 56278	do	Grant.
Summit-Delzer Joint Venture	Box 1551 Rapid City, SD 57701	do	Lawrence.

The Mineral Industry of Tennessee

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Tennessee Division of Geology, for collecting information on all minerals.

By Robert F. May[1] and Robert E. Hershey[2]

Mineral raw materials produced in 1977 amounted to $521 million. Tennessee was the leading State in producing zinc ore, ball clay, and pyrites. It was fourth in the production of phosphate rock. The State was also an important processor of mineral raw materials, and sixth in the production of aluminum metal. Coal continued to lead in the value of mineral commodities produced during 1977 followed by stone and zinc ore. The prolonged strike at Cities Service Co.'s Copperhill operation, combined with lower copper prices, resulted in a large decrease in copper production and value.

Exploration continued to be active during 1977 for coal (including lignite), zinc ore, fluorspar, and oil and gas. The Jersey Miniere Zinc Co. continued development of its zinc mines in central Tennessee. Production at the Elmwood mine increased zinc ore output from 2,000 to 3,000 tons per day, and the new Gordonsville mine is being developed for 1978 production. The company's new electrolytic zinc refinery under construction at Clarksville was ahead of schedule. The Carthage Zinc Co. (a subsidiary of St. Joe Minerals Corp.) was sinking a shaft east of Carthage which is due for completion in 1978.

There were about 750 producing mines operating during 1977, coal mines being the most numerous with about 400 companies operating mines at some period of time during 1977, including 12 underground coal mines producing over 100,000 tons per year. Also, there were 130 stone quarries and approximately 90 sand and gravel operations active during 1977. There were 44 active clay pits and 63 phosphate rock surface mines. There were 11 large underground mines operating during 1977; 8 producing zinc ore and 3 producing copper ore.

Legislation and Government Programs.—The Tennessee Div. of Geology continued its statewide program of quadrangle geologic mapping and mineral resources investigations in cooperation with the Tennessee Valley Authority (TVA). In addition, the division continued its broad program of basic and applied research which included an extension of a grant from the U.S. Department of Energy. A seismic study of the Valley and Ridge Province comprised of two profiles across the Province was completed and stratigraphic drilling of the Chattanooga Shale was initiated.

The State Oil and Gas Board operating through the Div. of Geology continued its regulation of the growing oil and gas industry of Tennessee.

The Div. of Geology has opened a new office at Memphis that will relate to geologic hazards as well as other geologic research.

The Geologic Services Branch, TVA, continued its program of airborne magnetic surveying, resulting in additional coverage of 6,100 square miles in the eastern and middle parts of the State. Cataloging of mineral information in the U.S. Geological Survey's (USGS) Computer Resources Information Bank system was continued. To date, 4,100 mineral records have been entered by TVA into the system.

In addition, the Branch engaged in a wide variety of engineering geology investigations relating to the locations of steamplants. Major projects under construction, or near completion, included the Tellico Dam, Columbia Dam, and Racoon Mountain pumped storage reservoir and plant, and the Hartsville, Sequoyah, and Watts Bar nuclear plants.

USGS was engaged in a cooperative program of geological and topographic mapping with the Tennessee Div. of Geology. The USGS was also making water resources investigations under cooperative agreements with several State agencies.

The Tennessee Div. of Surface Mining continued its regulation of surface mining operations and the reclamation of lands disturbed by such mining. The division issued 277 permits covering 4,527 acres for surface mining during the year.

The Mining Enforcement and Safety Administration (MESA) operated out of five offices in the State (Knoxville, Jacksboro, Jellico, Jasper, and Franklin), in carrying out its regulatory responsibilities with regard to the health and safety of miners.

The Div. of Mines, Tennessee Department of Labor, operating out of Knoxville offices, carried out its mine inspection responsibilities under the State Mining Law.

Tennessee has a coal severance tax of 20 cents per ton of coal mined; reports and payments are due the 15th of each month. The State also has a production tax of 4.2 cents per 42-gallon barrel of crude oil and 5% of sales price of any gas sold.

Table 1.—Mineral production in Tennessee[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry ---------- thousand short tons--	175	$6,476	195	$7,878
Portland ----------do----	1,256	43,495	1,522	52,894
Clays[2] ----------do----	1,530	11,578	1,578	13,968
Coal (bituminous) ----------do----	9,283	151,372	9,433	206,226
Copper (recoverable content of ores, etc.) ----short tons--	11,131	15,494	6,187	8,266
Gold (recoverable content of ores, etc.)-----troy ounces--	W	W	13	2
Natural gas----------million cubic feet--	47	24	263	195
Petroleum (crude)-------- thousand 42-gallon barrels--	598	8,203	820	11,271
Phosphate rock ---------- thousand short tons--	1,801	[r]14,541	1,926	14,253
Sand and gravel ----------do----	11,096	25,129	12,773	29,197
Silver (recoverable content of ores, etc.) thousand troy ounces--	78	339	60	278
Stone ---------- thousand short tons--	37,600	86,156	41,911	100,137
Zinc (recoverable content of ores, etc.)------short tons--	82,512	61,059	90,438	62,221
Combined value of barite, clays (bentonite and fuller's earth), lime, pyrites, and items indicated by symbol W --	XX	15,862	XX	14,585
Total ----------	XX	[r]439,728	XX	521,371
Total 1967 constant dollars ----------	XX	225,712	XX	[p]257,349

[p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Combined value"figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes bentonite and fuller's earth; value included with "Combined value" figure.

Table 2.—Value of mineral production in Tennessee, by county[1] [2]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Anderson ----------	W	W	Stone, sand and gravel.
Bedford ----------	W	$1,108	Stone.
Benton----------	W	W	Sand and gravel, stone.
Bledsoe ----------	W	--	
Blount----------	$2,114	W	Stone.
Bradley ----------	W	W	Do.
Campbell ----------	W	W	Stone, sand and gravel.
Cannon ----------	W	161	Stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Tennessee, by county[1] [2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Carroll	$1,110	$1,430	Clays.
Carter	W	W	Stone.
Claiborne	W	W	Do.
Clay	W	138	Do.
Cocke	169	170	Do.
Coffee	W	W	Sand and gravel, stone.
Cumberland	W	W	Stone, sand and gravel.
Davidson	W	W	Stone, cement, clays.
Decatur	W	W	Stone, sand and gravel.
De Kalb	W	409	Stone.
Dickson	W	W	Do.
Dyer	374	W	Sand and gravel.
Fayette	47	99	Do.
Fentress	9,161	W	Stone.
Franklin	W	W	Cement, stone, sand and gravel, clays.
Gibson	W	W	Clays.
Giles	W	W	Phosphate rock, stone.
Grainger	W	W	Zinc, stone.
Greene	W	W	Stone, sand and gravel.
Grundy	W	W	Stone.
Hamblen	W	W	Do.
Hamilton	20,701	23,281	Cement, stone, sand and gravel, clays.
Hardeman	281	W	Sand and gravel.
Hardin	W	W	Stone, sand and gravel.
Hawkins	W	W	Stone.
Henry	W	W	Clays, sand and gravel.
Hickman	W	W	Phosphate rock.
Houston	W	--	
Humphreys	W	W	Stone, sand and gravel.
Jackson	W	W	Stone.
Jefferson	39,282	41,197	Zinc, stone.
Johnson	W	W	Stone.
Knox	26,834	32,343	Cement, zinc, stone, lime, sand and gravel, clays.
Lauderdale	81	125	Sand and gravel.
Lawrence	W	609	Stone, sand and gravel.
Lincoln	W	W	Stone.
Loudon	W	W	Sand and gravel, barite, stone.
McMinn	W	W	Lime, stone, sand and gravel.
McNairy	W	W	Sand and gravel, stone.
Macon	W	--	
Madison	95	158	Sand and gravel.
Marion	W	W	Cement, stone, sand and gravel.
Marshall	W	W	Stone.
Maury	W	W	Phosphate rock, stone.
Meigs	W	W	Stone.
Monroe	W	W	Do.
Montgomery	W	W	Do.
Moore	182	W	Do.
Morgan	W	--	
Obion	279	640	Sand and gravel.
Overton	1,135	468	Stone.
Perry	W	406	Sand and gravel.
Pickett	W	62	Stone.
Polk	27,134	16,653	Copper, pyrites, zinc, silver, gold.
Putnam	W	W	Stone, sand and gravel.
Rhea	W	W	Stone.
Roane	W	W	Stone, sand and gravel.
Robertson	W	W	Stone.
Rutherford	2,587	2,229	Do.
Scott	W	--	
Sequatchie	W	W	Stone.
Sevier	W	W	Stone, sand and gravel.
Shelby	7,228	10,366	Sand and gravel.
Smith	W	W	Zinc, stone.
Stewart	W	W	Sand and gravel, stone.
Sullivan	W	W	Cement, stone, clays.
Sumner	W	W	Stone.
Tipton	582	919	Sand and gravel.
Unicoi	W	W	Stone, sand and gravel.
Union	3,431	2,200	Do.
Van Buren	W	--	
Warren	W	W	Stone.
Washington	W	--	
Wayne	148	136	Sand and gravel.
Weakley	6,458	7,919	Clays.
White	W	W	Stone.
Williamson	W	W	Phosphate rock, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Tennessee, by county[1] [2] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Wilson	W	W	Stone.
Undistributed[3]	$290,321	$378,148	
Total[4]	[r]439,728	521,371	

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Cheatham, Chester, Crockett, Hancock, Haywood, Henderson, Lake, Lewis, and Trousdale.

[2] The values of petroleum and natural gas are based on an average price per barrel and cubic foot, respectively, for the State.

[3] Includes some sand and gravel, natural gas, petroleum, and coal that cannot be assigned to specific counties and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Tennessee business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	1,834.0	1,906.0	+3.9
Unemployment do	110.0	120.0	+9.1
Employment (nonagricultural):			
Mining do	9.4	9.2	-2.1
Manufacturing do	486.1	506.5	+4.2
Contract construction do	73.8	75.6	+2.4
Transportation and public utilities do	73.7	77.0	+4.5
Wholesale and retail trade do	339.5	349.8	+3.0
Finance, insurance, real estate do	69.3	70.4	+1.6
Services do	240.5	250.5	+4.2
Government do	283.1	289.7	+2.3
Total nonagricultural employment do	1,575.4	1,628.7	+3.4
Personal income:			
Total millions	$22,462	$24,869	+10.7
Per capita	$5,305	$5,785	+9.0
Construction activity:			
Number of private and public residential units authorized	19,136	26,467	+38.3
Value of nonresidential construction millions	$347.5	$418.3	+20.4
Value of State road contract awards do	$141.8	$237.1	+67.2
Shipments of portland and masonry cement to and within the State thousand short tons	1,481	1,654	+11.7
Mineral production value:			
Total crude mineral value millions	$439.7	$521.4	+18.6
Value per capita, resident population	$104	$121	+16.3
Value per square mile	$10,409	$12,342	+18.6

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

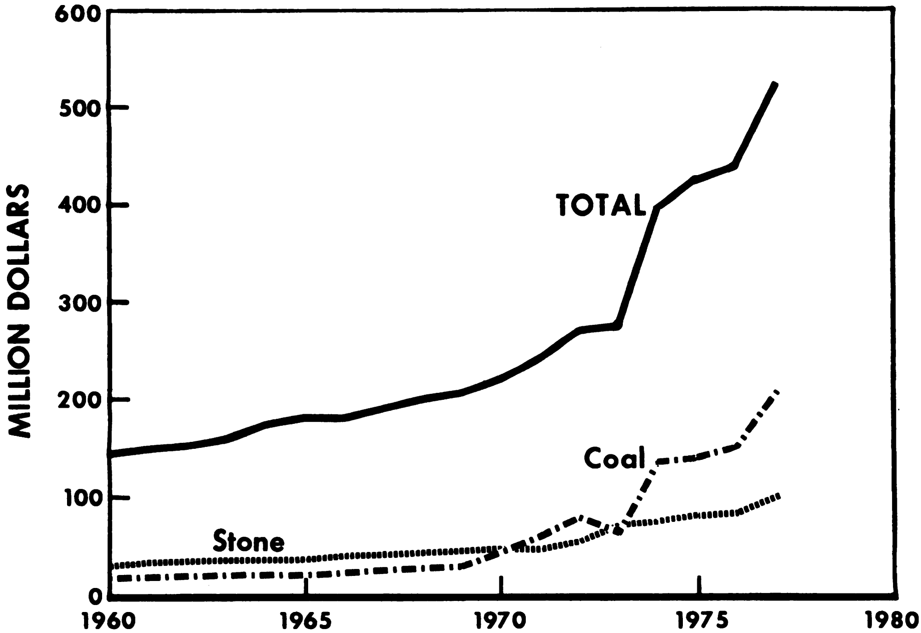

Figure 1.—Value of stone, coal, and total value of mineral production in Tennessee.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for 45% of the total value of minerals produced in Tennessee in 1977, a slight increase over that of 1976. Principal commodities, in order of decreasing value, were stone, cement, sand and gravel, phosphate rock, and clays.

Barite.—Ground and crushed barite was produced by the C. R. Wood Co., Inc., from its mine and concentration plant in Loudon County. Production was shipped to out-of-State purchasers for use as ground barite in paint manufacture. Production decreased 41% in 1977 from the 1976 level.

Cement.—Production of portland cement in 1977 was 1,476,000 tons with sales of 1,522,000 tons, valued at nearly $53 million, an increase of 21% over that of 1976. Masonry cement production increased 8% over 1976 production to nearly 211,000 tons. Shipments increased 11% to over 194,000 tons, and its value increased nearly 22% as the result of the increase of average per ton value from $36.98 to $40.50.

Six plants, operated by four companies, produced portland cement in Tennessee: Penn-Dixie Industries, Inc., at Richard City and Kingsport; General Portland, Inc., at Chattanooga; Ideal Basic Industries, Inc., at Knoxville; and Gulf and Western Industries, Inc., (Marquette Co.) at Nashville and Cowan. All of these companies except Ideal Basic Industries, Inc., produced masonry cement also.

Ready-mix companies were the largest users of portland cement using 62% of the output, followed by concrete product manufacturers (22%), building material dealers (9%), and all others (7%).

Ideal Basic Industries, Inc., began a $28 million construction project at its Knoxville facility that will replace four small, wet-process kilns with a new precalcining preheater kiln. Plant capacity will be increased from 470,000 to 580,000 tons per year while reducing fuel consumption about 50%.[3]

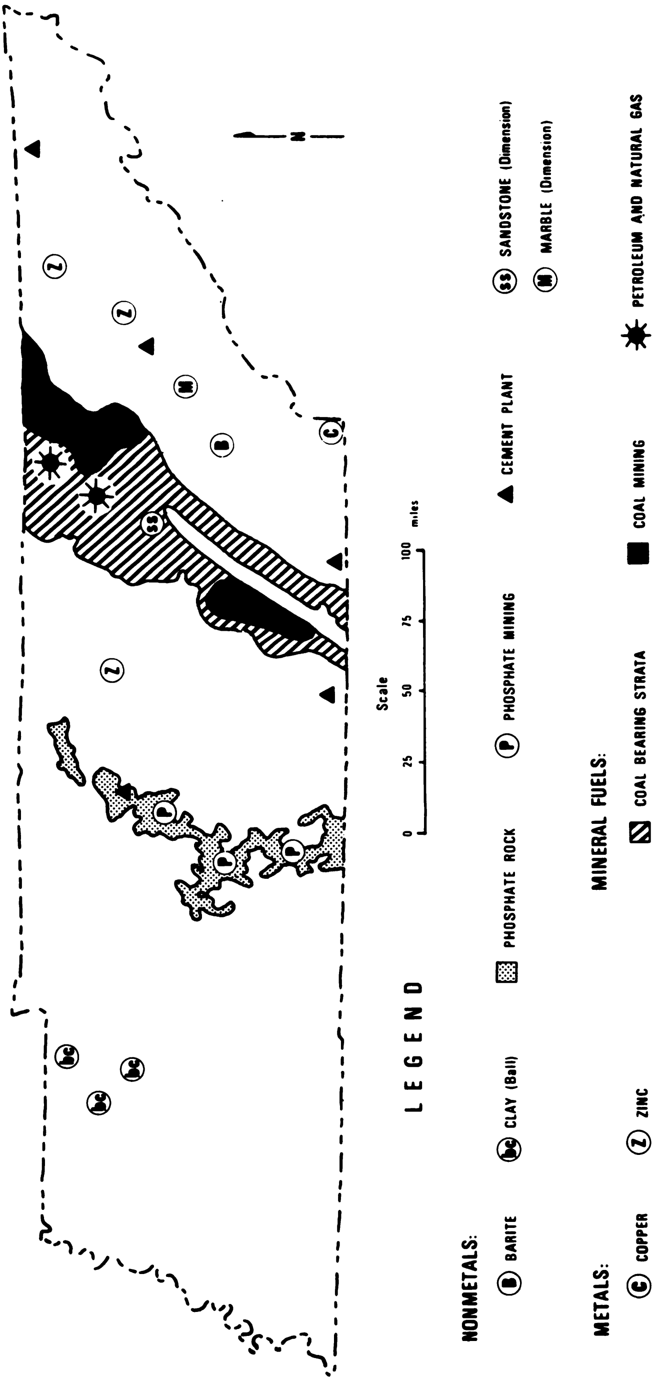

Figure 2.—Generalized map of selected mining areas and industries in Tennessee.

Table 4.—Tennessee: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	6	6
Production	1,288,952	1,476,367
Shipments from mills:		
Quantity	1,256,210	1,521,816
Value	$43,495,480	$52,894,442
Stocks at mills, Dec. 31	152,271	153,261

Table 5.—Tennessee: Masonry cement salient statistics

(Short tons)

	1976	1977
Number of active plants	5	5
Production	194,957	210,628
Shipments from mills:		
Quantity	175,104	194,521
Value	$6,476,048	$7,878,481
Stocks at mills, Dec. 31	21,937	21,244

Clays.—Tennessee led the Nation in producing ball clay in 1977, accounting for 70% of the total. Production of 628,428 tons valued at $12,511,168 was an increase in tonnage of 22% and in value of 25% over that of 1976. On the other hand, production of common clay and shale decreased 6% in tonnage and 8% in value from 949,668 tons and $1,457,249 in 1976. Ball clay was produced from 18 open pits in Weakley, Henry, Carroll, and Gibson Counties. Principal producers were Kentucky-Tennessee Clay Co., Cyprus Industrial Minerals Co., H. C. Spinks Clay Co., Inc., and Old Hickory Clay Co. Major uses for ball clay were pottery, floor and wall tile, and sanitary ware.

Common clay and shale was produced by 9 companies from 17 open pits. General Shale Products Corp. was by far the largest producer in operating five mines in four counties. Other significant producers were General Portland, Inc., Tennlite, Inc., W. G. Bush and Co., and Shalite Corp. Principal uses for common clay and shale were in the production of face and common brick, portland cement, concrete block, lightweight aggregate, and structural concrete.

Fuller's earth was mined in Henry County by Lowe's, Inc. Tonnage decreased 6% and value decreased 7% from that of 1976.

Table 6.—Tennessee: Ball clay sold or used by producers, by kind and use

(Short tons)

Use	1976			1977		
	Airfloat	Unprocessed	Total	Airfloat	Unprocessed	Total
Fine china - dinnerware	31,749	--	31,749	25,476	--	25,476
Electrical porcelain	W	W	14,320	W	W	7,150
Floor and wall tile, ceramic	W	W	71,421	W	W	33,254
Glazes, glass, and enamel	496	--	496	--	--	--
Pottery	W	W	191,855	W	W	199,859
Sanitary ware	W	W	68,993	--	W	W
Other uses[1]	211,532	201,863	[2]66,806	371,091	170,975	[2]301,803
Exports	52,000	16,105	68,105	32,043	28,843	60,886
Total	295,777	217,968	513,745	428,610	199,818	628,428

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes asphalt emulsion (1976), common brick, catalysts (oil refining), china/dinnerware (1977), crockery and other earthenware, electrical porcelain (1977), fertilizers, fiberglass (1977), firebrick (block and shapes), floor and wall tile (ceramic, 1977), flower pots, high alumina refractories, kiln furniture, mortar and cement, mineral wool and insulation (1976), oil and grease absorbents (1976), paper coating (1977), paper filling (1977), pesticides and related products, pet absorbent (1977), pottery (1977), rubber, asphalt tile (1977), quarry tile (1976), waterproofing and sealing, and data indicated by symbol W.

[2] Incomplete total; remainder included with total for each specific use.

Table 7.—Tennessee: Common clay sold or used by producers, by use

(Short tons)

Use	1976	1977
Brick	580,444	543,704
Portland cement	199,530	197,236
Concrete block	232,650	205,728
Structural concrete	3,300	3,000
Total	1,015,924	949,668

Fluorspar.—U.S. Borax and Chemical Co. completed drilling over 210 holes, ranging in depth from 300 to 1,000 feet in the Stephens area near Sweetwater in Monroe County. A preliminary feasibility study on the project area was completed and an environmental study to collect baseline data was begun.

Graphite.—Synthetic graphite was produced from petroleum coke by Union Carbide Corp. at its plant in Maury County near Columbia. Manufacture of electric furnace electrodes was the primary use of the graphite.

Lime.—Quicklime and hydrated lime was produced from two plants in eastern Tennessee in 1977 and was 3% below 1976 production. Bowaters Southern Paper Corp. operated a plant at Calhoun in McMinn County, and Williams Lime Manufacturing Co. operated a plant in Knoxville, Knox County.

Perlite.—The Chemrock Corp. produced perlite at its Nashville plant. Value of expanded perlite in 1977 was up 22% over that of 1976. The product was used in insulation, agricultural and construction aggregates, and as a filter aid.

Phosphate Rock.—1977 marketable production of concentrate, produced from 3,646,037 tons of surface-mined phosphate rock, increased 7% over that of 1976 to 1,926,044 tons. However, a decrease in the average price from $8.07 to $7.40 resulted in an overall decrease in value of 2% to $14,253,000. In spite of the increased production, Tennessee ranked fourth in the Nation.

Phosphate rock was produced in Maury, Williamson, Hickman, and Giles Counties in the Columbia-Mt. Pleasant district of south-central Tennessee. Major producing companies (in order of decreasing tonnage) were the Monsanto Industrial Chemical Co., Hooker Chemicals and Plastics Corp. (a subsidiary of Occidental Petroleum Corp.), and Stauffer Chemical Co. A fourth producer was M. C. West, Inc. Surface mine permits were issued for 1,614 acres. Mining operations disturbed 828 acres and the State approved the reclamation of 679 acres.

The average grade of ore mined was slightly over 20% P_2O_5. Most of the Tennessee production was reduced to elemental phosphorus in electric furnaces of the major producers, with the elemental phosphorus being converted into a wide variety of industrial chemicals.

Table 8.—Tennessee: Clays sold or used by producers

Year and type	Quantity (short tons)	Value	
		Total	Average per ton
1976:			
Ball clay	513,745	$9,996,374	$19.46
Common clay and shale	1,015,924	1,581,536	1.56
Total	1,529,669	11,577,910	XX
1977:			
Ball clay	628,428	12,511,168	19.91
Common clay and shale	949,668	1,457,249	1.53
Total	1,578,096	13,968,417	XX

XX Not applicable.

The grade of the marketable rock sold or used during the year, compared with previous years, was:

Grade, BPL content[1]	Percent distribution		
	1975	1976	1977
Less than 60%	80.9	72.1	75.4
60%-66%	17.5	26.8	24.6
66%-70%	1.6	1.1	--

[1] 1.0% BPL (bone phosphate of lime) = 0.458% P_2O_5.

Pyrites.—Tennessee led the Nation in pyrite production in 1977. However, because of a strike that closed the Copperhill facility of Cities Service Co. from mid-April to mid-August, tonnage dropped 43% from the 1976 production level. Processing of sulfide concentrates from the flotation plant yielded industrial chemicals (mostly sulfuric acid) and iron pellets. The company also continued revamping of their pellet plant during the year.

Sand and Gravel.—Sand and gravel production was up 15% over that of 1976 from 11.1 million tons to nearly 12.8 million tons in 1977. Eighty-nine pits were operated by 69 companies or governmental entities in 34 counties, with western Tennessee the most important producing area. As in prior years, Shelby County (Memphis) with 16 mines was the leading producer with 45% of the total sold or used during 1977. Benton County ranked second with four mines and 11% of the total and was the leading producer of industrial sand (86% of the total) used for glass and other industrial purposes.

Table 9.—Tennessee: Phosphate rock sold or used by producers

Year	Rock	P_2O_5 content	Value	
	(thousand short tons)		Total (thousands)	Average per ton
1973	2,665	699	$13,812	$5.18
1974	2,607	708	20,594	7.90
1975	2,393	617	29,921	12.50
1976	1,908	494	15,326	8.03
1977	1,900	480	14,064	7.40

Table 10.—Tennessee: Production of phosphate rock

Year	Mine production (thousand short tons)		Marketable production (thousand short tons)		Value, marketable production	
	Rock	P_2O_5	Rock	P_2O_5	Total (thousands)	Average per ton
1973	4,168	894	2,512	653	$12,799	$5.10
1974	4,135	821	2,411	648	18,465	7.66
1975	4,052	808	2,291	588	28,803	12.57
1976	3,332	681	1,801	464	[r]14,541	8.07
1977	3,646	733	1,926	487	14,253	7.40

[r] Revised.

Table 11.—Tennessee: Sand and gravel sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Anderson	1	60	150	1	4	6
Benton	5	1,360	3,837	4	1,466	5,462
Campbell	2	W	W	2	73	W
Carroll	1	([1])	1	--	--	--
Coffee	2	392	W	1	326	896
Cumberland	2	W	W	4	182	358
Decatur	1	W	W	1	237	403
Dyer	3	265	374	2	W	W
Fayette	3	71	47	2	59	99
Hardeman	3	193	281	2	W	W
Hardin	2	W	W	3	117	192
Knox	2	W	W	3	298	933
Lauderdale	6	77	81	6	77	125
Lawrence	1	15	11	1	15	15
Madison	3	75	95	3	95	158
Marion	1	16	48	1	W	W
Obion	5	209	279	5	325	640
Perry	2	W	W	1	239	406
Shelby	18	4,249	7,228	16	5,776	10,366
Tipton	6	393	582	6	535	919
Union	1	70	140	1	45	90
Wayne	1	W	148	1	W	136
Other counties[2]	22	3,647	11,831	23	2,906	7,994
Total[3]	93	11,096	25,129	89	12,773	29,197

W Withheld to avoid disclosing company proprietary data; included with "Other counties."

[1] Less than 1/2 unit.

[2] Includes Franklin, Greene, Hamilton, Hawkins (1976), Henry, Houston (1976), Humphreys, Loudon, McMinn, McNairy, Putnam, Roane, Sevier, Stewart (1977), Unicoi, and Washington (1976) Counties.

[3] Data may not add to totals shown because of independent rounding.

Table 12.—Tennessee: Sand and gravel sold or used by producers, by use

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	5,533	$10,673	$1.93	6,634	$13,711	$2.07
Gravel	4,678	9,465	2.02	5,390	10,542	1.96
Total[1] or average	10,211	20,138	1.97	12,023	24,253	2.02
Industrial sand	885	4,991	5.64	750	4,945	6.59
Grand total[1] or average	11,096	25,129	2.26	12,773	29,197	2.29

[1] Data may not add to totals shown because of independent rounding.

Table 13.—Tennessee: Construction sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	3,512	$7,250	$2.06	3,004	$6,890	$2.29
Concrete products (cement blocks, bricks, pipe, etc.)	1,590	3,862	2.43	2,008	4,812	2.40
Asphaltic concrete aggregates and other bituminous mixtures	1,331	2,680	2.01	1,837	3,993	2.17
Roadbase and coverings	3,056	5,185	1.70	4,103	7,127	1.74
Fill	541	705	1.30	779	852	1.09
Other uses	182	456	2.51	292	578	1.98
Total[1] or average	10,211	20,138	1.97	12,023	24,253	2.02

[1] Data may not add to totals shown because of independent rounding.

Silicon Carbide.—The Carborundum Co. produced silicon carbide in 1977 at its Jacksboro plant in Campbell County. The product was used for abrasives, refractories, and metallurgical applications.

Stone.—Stone production for 1977 was up 11% from that of 1976 and amounted to 41.9 million tons valued at $100.1 million. It was the second most valuable mineral commodity produced in Tennessee, exceeded only by coal.

Crushed stone accounted for more than 99% (both tonnage and value) of total stone production in 1977. Crushed stone was produced in 64 counties located in central and eastern Tennessee by 82 companies from 130 limestone quarries with a small amount as byproduct from dimension stone operations and zinc mining. Seven companies producing over 1 million tons each accounted for 52% of the State's total production. In order of descending tonnage they were Vulcan Materials Co. operating 22 quarries; ASARCO Incorporated, 5 quarries; Ralph Rogers and Co., Inc., 6 quarries; Hoover, Inc., 2 quarries; Koppers Co., Inc., 4 quarries; Webb Stone Co., 2 quarries; and Porter Brown Limestone Co., 2 quarries. End uses for crushed stone were dense-graded roadbase (32%), roadstone (17%), concrete aggregate (15%), bituminous aggregate (7%), agricultural limestone (8%), macadam aggregate (6%), cement manufacture (5%), and all other uses (10%).

Dimension stone was produced by six companies from eight quarries for rubble, rough blocks, stone veneer for homes, and other miscellaneous uses. Output declined 31% from 1976 production to 13,400 tons valued at $941,000. Leading producers were Turner Stone Co., John J. Craig Co., and Crab Orchard Stone Co., Inc. The Georgia Marble Co. closed all of its Tennessee operations.

Table 14.—Tennessee: Stone sold or used by producers in 1977, by type

Type	Quarries	Quantity (thousand short tons)	Value (thousands)	Value per ton
Dimension	8	13	$941	$72.38
Crushed and broken	130	41,897	99,196	2.37
Total or average	138	[1]41,911	100,137	XX

XX Not applicable.
[1] Data do not add to total shown because of independent rounding.

Table 15.—Tennessee: Crushed limestone[1] sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Campbell	3	1,236	2,270	3	1,560	2,997
Cannon	1	71	W	1	W	W
Clay	1	W	W	1	69	138
Cocke	1	112	169	1	113	170
Cumberland	3	797	2,259	2	W	W
Davidson	8	3,747	8,503	8	4,645	10,727
De Kalb	2	W	W	2	231	409
Fentress	2	292	664	2	W	W
Franklin	4	1,040	2,544	4	1,125	2,981
Giles	1	W	W	1	247	601
Greene	4	368	888	4	W	W
Jefferson	7	1,995	4,516	7	2,203	5,771
Knox	7	2,783	6,038	8	3,155	7,518
Lawrence	1	W	W	1	239	594
Marion	3	1,227	2,721	3	1,217	2,786
Moore	1	66	182	2	W	W
Overton	2	W	W	2	215	468
Pickett	1	34	34	1	62	62
Putnam	3	525	1,243	3	598	1,482
Rutherford	3	1,138	2,587	3	908	2,229
Stewart	1	W	W	1	191	334
Unicoi	1	169	279	1	248	423
Union	3	459	1,850	3	510	2,110
Van Buren	1	200	300	1	W	W
Washington	5	242	415	5	114	196
Undistributed[2]	57	21,074	46,220	60	24,248	57,057
Total[3]	126	37,574	83,677	130	41,893	99,053

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes dolomite.

[2] Includes Anderson, Bedford, Benton, Blount, Bradley, Carter, Claiborne, Coffee, Decatur, Dickson, Grainger (1977), Grundy, Hamblen, Hamilton, Hardin, Hawkins, Humphreys, Jackson, Johnson, Lincoln, McMinn, Macon, Marshall, Maury, Meigs, Monroe, Montgomery, Rhea, Roane, Robertson, Sequatchie, Sevier, Smith, Sullivan, Sumner, Warren, White, Williamson, and Wilson Counties.

[3] Data may not add to totals shown because of independent rounding.

Table 16.—Tennessee: Crushed limestone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	12,170	26,440	13,330	30,410
Roadstone	6,571	14,290	7,683	17,050
Concrete aggregate	5,619	12,060	6,236	15,040
Bituminous aggregate	2,453	5,205	3,888	8,686
Agricultural limestone	2,936	6,864	2,878	7,399
Macadam aggregate	2,433	5,401	1,853	4,197
Cement manufacture	1,815	4,153	1,841	4,692
Surface treatment aggregate	1,440	3,261	1,664	3,825
Mineral food	W	W	537	2,207
Riprap and jetty stone	594	1,262	483	962
Railroad ballast	W	W	266	505
Filter stone	W	W	259	638
Acid neutralization	--	--	231	W
Sulfur dioxide	--	--	66	173
Drain fields	W	W	W	W
Other uses[2]	1,544	4,745	682	3,269
Total[3]	37,574	83,677	41,893	99,053

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, marble, and sandstone (1976).

[2] Includes stone used in lime manufacture, mine dusting, whiting, other filler, glass manufacture, asphalt filler, terrazzo and exposed aggregate, unspecified uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 17.—Tennessee: Dimension stone[1] sold or used by producers, by use

Use	1976 Short tons	1976 Cubic feet (thousands)	1976 Value (thousands)	1977 Short tons	1977 Cubic feet (thousands)	1977 Value (thousands)
Rubble	2,617	33	$90	W	W	W
House stone veneer	1,690	22	54	2,340	30	$74
Cut stone	W	W	W	1,944	25	352
Sawed stone	1,404	16	247	W	W	W
Irregular-shaped stone	2,569	33	86	W	W	W
Dressed flagging	54	1	9	75	1	13
Other uses[2]	11,140	129	1,841	9,050	106	502
Total[3]	19,474	233	2,328	13,409	162	941

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes sandstone and marble.

[2] Includes stone used as rough blocks, rough flagging, rough monumental (1976), unspecified uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Sulfuric Acid.—Because of the strike from mid-April to mid-August, production of sulfuric acid by Cities Service Co. from sulfuric gases generated from roasting and smelting pyrite and copper concentrates at their Copperhill operations dropped 51% in 1977 from the previous 1976 high.

Vermiculite.—Production of expanded crude vermiculite in 1977 by the Construction Products Div. of W. R. Grace & Co. from its Nashville plant increased 18% over that for 1976. Principal uses, in descending order, were block insulation, concrete aggregate, horticulture, and soil conditioning.

MINERAL FUELS

Mineral fuels accounted for 42% of the total of mineral production in 1977.

Coal (Bituminous).—Coal production was up 2% to 9.4 million tons for 1977. Valued at $206 million, it was the highest valued mineral commodity produced in the State.

Coke.—The Chattanooga Coke and Chemical Co., Inc. (The Mead Corp.), continued as the State's only producer of coke from its plant at Alton Park in Hamilton County.

Nuclear Fuel.—Nuclear Fuel Services, Inc., a division of Getty Oil Co., continued operation of its Erwin plant that engages in specialty and development work on nuclear fuels.

Petroleum and Natural Gas.—Crude oil production for 1977 was 819,650 barrels, an increase of 37% over that of 1976. Marketed natural gas was 262,290,000 cubic feet. Most of the activity was centered in Scott, Morgan, and Fentress Counties.

METALS

Tennessee metals production for 1977 accounted for 14% of the State's total mineral value. Zinc production was the dominant metal with almost 88% of the total value, followed by copper with nearly 12%. Other metals (silver and gold), as byproducts of copper and sulfuric acid production, accounted for less than 1% of the total value. Value of total metals dropped 8% from 1976 value largely due to a sharp decrease in copper production brought about by the depressed copper market and a prolonged strike at Cities Service Co.'s Copperhill operation, which was the State's only copper producer.

Aluminum.—Although the value of aluminum metal production for 1977 increased 5% over that of 1976, tonnage decreased 9% with the result that Tennessee dropped from second to sixth place in the Nation's total aluminum output. Two companies, Aluminum Company of America at Alcoa in Blount County and Consolidated Aluminum Corp. at New Johnsonville in Humphreys County, produced primary aluminum from imported alumina.

Copper.—Copper production in 1977 dropped nearly 50% in both tonnage and value from that of 1976. Production was 6,187 tons of copper valued at $8.3 million, all from Cities Service Co. at Copperhill. The Copperhill facility operated three underground mines — Boyd, Calloway, and Cherokee — and the London flotation plant where these concentrates were produced — copper, pyrites (iron), and zinc. Zinc concentrates were sold and shipped out-of-State. Pyrites (iron) and copper concentrates were processed by roasting and smelting operations to produce sulfuric acid, copper metal, and iron calcine. The iron calcine was further processed into iron oxide pellets which were sold and shipped.

Table 18.—Tennessee: Mine production (recoverable) of gold, silver, copper, and zinc

		1975	1976	1977
Mines producing: Lode		11	10	11
Material sold or treated:				
Ore:				
Copper-zinc	thousand short tons	1,635	2,034	1,250
Zinc	do	3,106	3,125	3,744
Total	do	4,741	5,159	4,995
Production:				
Quantity:				
Gold	troy ounces	W	W	13
Silver	do	53,752	77,890	60,246
Copper	short tons	10,041	11,131	6,187
Zinc	do	83,293	82,512	90,438
Value:				
Gold	thousands	W	W	$2
Silver	do	$238	$339	278
Copper	do	12,893	15,494	8,266
Zinc	do	64,968	61,059	62,221
Total		W	W	70,767

W Withheld to avoid disclosing company proprietary data.

Ferroalloys.—In 1977 Tennessee held its third ranked position in the Nation's production of ferroalloys, although tonnage and value dropped 4% and 7%, respectively, from that of 1976. Six companies produced 187,300 tons valued at $63 million.

Roane Electric Furnace Co., Inc. (a subsidiary of Engelhard Minerals & Chemicals Corp.) produced ferrosilicon, ferromanganese, and silicomanganese in an electric furnace at Rockwood in Roane County. Tennessee Metallurgical Corp. (a subsidiary of International Minerals & Chemical Corp.) produced ferrosilicon at Kimball in Marion County, and Chromium Mining & Smelting Corp. produced ferrochromium from electric furnace operations at Woodstock in Shelby County. Monsanto Industrial Chemical Co., Stauffer Chemical Co., and Hooker Chemicals and Plastics Corp. produced ferrophosphorus as a byproduct of their electric furnace operations in Maury County.

The principal uses of ferroalloys were as additives and alloying elements in the manufacture of carbon steels, stainless steels, other alloy steels, cast irons, and various alloys.

Gold.—A small amount of gold was produced as a byproduct from Cities Service Co.'s copper refining operations at Copperhill.

Iron.—Iron pellets were produced at Cities Service Co.'s Copperhill operations from iron calcine that is a byproduct of their pyrite roasting process. The product was sold and shipped to the iron and steel industry. The iron pellet plant revamp program continued during 1977 with completion of installation of a new gas cleaning system designed to meet environmental requirements and improve reliability of operations.[4]

Manganese.—Foote Mineral Co. continued production of electrolytic manganese metal at its plant in New Johnsonville. Silicomanganese was produced by Roane Electric Furnace Co. at Rockwood in Roane County. Their products were used primarily by the steel and aluminum industries. Overall consumption of manganese decreased from that of 1976. Lower demand, coupled with heavy imports, resulted in lower domestic prices for both alloys and electrolytic metal.

Rare-Earth Metals and Thorium.—W. R. Grace & Co., Davison Chemical Div., processed imported monazite concentrates and a minor amount of bastnäsite for rare earths and thorium at its Chattanooga plant. Production of all types of products used for chemical processing and polishing compounds increased more than 10% over 1976 production. W. R. Grace was the Nation's only monazite processor.

Silver.—Silver was recovered at out-of-State refineries as a byproduct of refining copper concentrates from Cities Service Co.'s Copperhill operations. Production decreased 23% in 1977 from 78,000 troy ounces in 1976 to 60,000 troy ounces valued at $278,000 because of the strike that idled operations from mid-April to mid-August.

Titanium.—Production of titanium dioxide pigment using ilmenite and rutile concentrates from Florida, Georgia, New

Jersey, and Australia continued at E. I. du Pont de Nemours & Co., Inc.'s facility at New Johnsonville. This plant, which was the largest of its type in the United States, produced a major portion of Du Pont's titanium oxide which was up 4% over their 1976 production.

Zinc.—After dropping to second place behind Missouri in 1976, Tennessee regained first place among zinc-producing States with 90,438 tons of zinc valued at over $62 million in 1977. This was a 10% increase in production, but because of lower zinc prices, value increased only 2%.

Eight mines, seven in eastern Tennessee and one in middle Tennessee, produced zinc ore. Copper-zinc ore was produced from three mines in southeast Tennessee.

The Mascot-Jefferson City zinc district had four mines operated by ASARCO Incorporated: The Coy, Immel, New Market, and Young; the Idol and Jefferson City mines operated by The New Jersey Zinc Co.; and the Zinc Mine Works operated by United States Steel Corp. New Jersey Zinc continued development of their Beaver Creek and Lost Creek mines in this district.

In the middle Tennessee zinc district, the Jersey Miniere Zinc Co. (a joint venture of The New Jersey Zinc Co. and Union Miniere of Belgium) operated the Elmwood mine and continued development of their Gordonsville mine, both in Smith County. North of the Elmwood mine, the Carthage Zinc Co. began a 3-year, $5 million exploration and development project.

In the Ducktown district, Cities Service Co. continued production of copper-zinc ore from its Boyd, Calloway, and Cherokee mines and continued stripping overburden from the Cherokee open pit.

The Jersey Miniere Zinc Co. continued construction of their new electrolytic zinc refinery near Clarksville which is scheduled for completion in late 1978.

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[1] State Liaison Officer, Bureau of Mines, Nashville, Tenn.

[2] State geologist, Department of Conservation, Tennessee Division of Geology, Nashville, Tenn.

[3] Ideal Basic Industries, Inc. Annual Report 1977, p. 7.

[4] Cities Service Co. 1977 Annual Report, p. 13.

Table 19.—Tennessee: Tenor of zinc ore milled and concentrate produced in 1977

Total material	short tons	3,744,422
Metal content of ore: [1] Zinc	percent	2.37
Concentrates produced and average content:		
Zinc	short tons	158,657
Recovery ratio	percent	4.24
Average zinc content	do	62.37

[1] Figure represents metal content of crude ore only as contained in the concentrate.

Table 20.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum smelters:			
Aluminum Co. of America	Box 158 Alcoa, TN 37701	Plant	Blount.
Consolidated Aluminum Corp	1102 Richmond St. Jackson, TN 38301	do	Humphreys.
Barite:			
C. R. Wood Co., Inc	Box 284 Sweetwater, TN 37874	Open pit mine and mill.	Loudon.
Cement:			
General Portland, Inc	1300 American National Bank Bldg. Chattanooga, TN 37402	Plant	Hamilton.
Ideal Basic Industries, Inc	Box 6238 Knoxville, TN 37914	do	Knox.
Gulf and Western Industries, Inc. (Marquette Co.)	First American Center Nashville, TN 37238	Plants	Davidson and Franklin.
Penn-Dixie Industries, Inc	60 East 42d St. New York, NY 10017	do	Marion and Sullivan.
Clays:			
Cyprus Industrial Minerals Co	Box 111 Gleason, TN 38229	Pits and plants	Carroll and Weakley.
Kentucky-Tennessee Clay Co	Box 449 Mayfield, KY 42066	do	Carroll, Gibson, Henry, Weakley.
Lowe's, Inc	Box 819 Paris, TN 38242	do	Henry.

See footnotes at end of table.

Table 20.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clays —Continued			
H. C. Spinks Clay Co., Inc	Box 820 Paris, TN 38242	Pits and plants.	Carroll, Henry, Weakley.
Coke:			
The Mead Corp.[1]	4800 Central Ave. Chattanooga, TN 37410	Plant	Hamilton.
Copper:			
Cities Service Co.[2]	Copperhill, TN 37317	Underground mines and plant.	Polk.
Ferroalloys:			
Chromium Mining & Smelting Corp	Box 28538 Memphis, TN 38128	Plant	Shelby.
Hooker Chemicals and Plastics Corp	Box 591 Columbia, TN 38401	do	Maury.
Monsanto Industrial Chemical Co	Columbia, TN 38401	do	Do.
Stauffer Chemical Co	Box 472 Mount Pleasant, TN 38474	do	Do.
Tennessee Metallurgical Corp	818 Hamilton Bank Bldg. Chattanooga, TN 37402	do	Marion.
Graphite, artificial: Union Carbide Corp	Box 513 Columbia, TN 38401	do	Maury.
Lime:			
Bowaters Southern Paper Corp	Calhoun, TN 37309	do	McMinn.
Williams Lime Manufacturing Co	Box 2286 Knoxville, TN 37901	do	Knox.
Perlite, expanded: Chemrock Corp	Osage St. Nashville, TN 37208	do	Davidson.
Petroleum refinery: Delta Refinery Co	543 West Mallory Ave. Memphis, TN 38106	do	Shelby.
Phosphate rock:			
Hooker Chemicals and Plastics Corp.[1]	Box 591 Columbia, TN 38401	do	Maury.
Monsanto Industrial Chemical Co.[1]	Columbia, TN 38401	do	Do.
Stauffer Chemical Co.[1]	Box 472 Mount Pleasant, TN 38474	do	Do.
Sand and gravel:			
C A C Corp	3390 Overton Crossing Memphis, TN 38127	Dredge	Shelby.
Hardy Sand Co	Box 507 Camden, TN 38320	Pits	Benton.
Memphis Stone and Gravel Co	Box 38269 Germantown, TN 38138	do	Benton and Shelby.
Clyde Owen Sand and Gravel, Inc	10636 Shelton Rd. Collierville, TN 38017	do	Shelby.
Standard Construction Co., Inc	Box 38289 Germantown, TN 38138	do	Do.
Stone:			
American Limestone Co	Box 2389 Knoxville, TN 37901	Quarries	Jefferson, Knox, Sullivan.
Hoover, Inc	Box 7201 Nashville, TN 37210	do	Davidson and Rutherford.
Koppers Co., Inc. (Stoneman, Inc.)	Box 2098 Chattanooga, TN 37409	do	Bedford, Hamilton, Rutherford, Warren.
Ralph Rogers and Co., Inc. (Mid-South Pavers, Inc.)	720 Argyle Ave. Nashville, TN 37203	do	Various.
Vulcan Materials Co	Box 7 Knoxville, TN 37901	do	Do.
Vermiculite, exfoliated:			
W. R. Grace & Co	4061 Powell Ave. Nashville, TN 37204	Plant	Davidson.
Zinc:			
ASARCO Incorporated[3]	Mascot, TN 37806	Underground mines and plant.	Jefferson and Knox.
Jersey Miniere Zinc Co	Elmwood, TN 38560	Underground mine.	Smith.
The New Jersey Zinc Co	Box 32 Jefferson City, TN 37760	do	Jefferson.
United States Steel Corp	Jefferson City, TN 37760	do	Do.

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[1] Also ferroalloys.
[2] Also gold, silver, zinc, and pyrites.
[3] Also silver and stone.

The Mineral Industry of Texas

This chapter has been preparéd under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Bureau of Economic Geology, The University of Texas at Austin, for collecting information on all minerals except fuels.

By Murphy E. Hawkins[1] and L. E. Garner[2]

Texas mineral output in 1977, valued at $19,520 million, was 8% above that of 1976. The principal reason for the value increase was the inflationary trend in commodity prices because output of some of the more significant minerals, such as crude oil,

Table 1.—Mineral production in Texas[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	213	$10,596	254	$13,095
Portland do	7,388	271,066	8,482	331,758
Clays[2] do	3,706	8,847	3,682	11,465
Coal (lignite) do	14,063	W	W	W
Gem stones	NA	168	NA	160
Gypsum thousand short tons	1,531	6,322	1,718	8,837
Helium (crude) million cubic feet	12	[r]149	W	W
Iron ore (usable) thousand long tons, gross weight	566	W	W	W
Lime thousand short tons	1,455	43,983	1,612	49,965
Natural gas million cubic feet	7,191,859	5,163,755	7,051,027	6,367,077
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels	77,578	560,831	283,772	2,009,366
LP gases do	209,514	1,223,562		
Petroleum (crude) do	1,189,523	10,217,702	1,137,880	9,986,002
Salt thousand short tons	9,718	48,875	10,941	53,264
Sand and gravel do	47,848	103,217	55,495	133,420
Stone:				
Crushed do	54,841	99,816	65,446	122,784
Dimension do	15	1,836	27	3,922
Sulfur (Frasch) thousand long tons	3,415	W	3,480	W
Talc and soapstone short tons	199,663	1,071	233,024	2,191
Combined value of asphalt (natural), clays (fuller's earth and kaolin), fluorspar, graphite, magnesium chloride, magnesium compounds, sodium sulfate, uranium, vermiculite, and items indicated by symbol W	XX	381,413	XX	426,325
Total	XX	[r]18,143,209	XX	19,519,631
Total 1967 constant dollars	XX	9,312,909	XX	[p]9,634,890

[p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes fuller's earth and kaolin; value included in "Combined value" figure.

natural gas, and natural gas liquids, actually declined during the year. Value and production of major industrial minerals such as cement, stone, sand and gravel, and gypsum, rose significantly reflecting both the sustained high level of construction activity in the State as well as increases in unit value of these commodities.

Texas ranked first among the States in the output of crude petroleum, natural gas liquids, natural graphite, native asphalt, magnesium chloride, sulfur (Frasch), and crushed stone. The State ranked second in the output of natural gas, cement, clays, gypsum, salt, talc, natural sodium sulfate, and aluminum; third in sand and gravel, fluorspar, and crude helium; and fourth in lime.

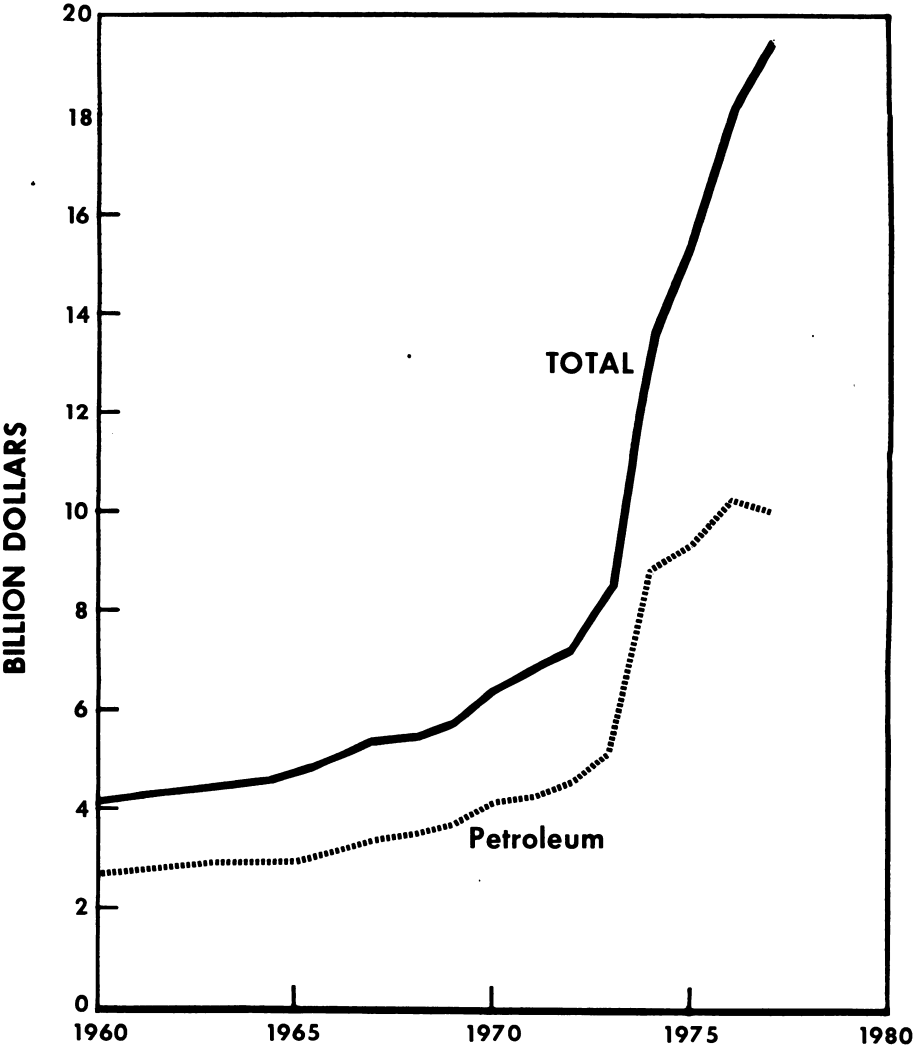

Figure 1.—Value of petroleum and total value of mineral production in Texas.

Table 2.—Value of mineral production in Texas, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Anderson	$160,753	--	
Andrews	487,213	--	
Angelina	525	--	
Aransas	18,870	--	
Archer	31,662	$18	Stone.
Armstrong	886	W	Sand and gravel.
Atascosa	53,343	W	Uranium, sand and gravel, stone.
Austin	22,653	--	
Bailey	W	--	
Bastrop	1,104	W	Clays.
Baylor	W	--	
Bee	49,126	W	Uranium.
Bell	3,381	3,426	Stone, sand and gravel.
Bexar	57,115	W	Cement, stone, lime, sand and gravel, clays.
Borden	102,716	W	Sand and gravel.
Bosque	W	W	Lime, stone.
Bowie	2,962	628	Sand and gravel, stone.
Brazoria	605,937	130,613	Magnesium chloride, salt, magnesium compounds, sand and gravel, stone.
Brazos	3,207	W	Sand and gravel.
Brewster	W	W	Fluorspar, sand and gravel.
Brooks	126,936	--	
Brown	7,193	W	Stone, clays.
Burleson	1,403	134	Sand and gravel.
Burnet	W	W	Stone, graphite.
Caldwell	21,112	--	
Calhoun	39,445	W	Lime, stone.
Callahan	9,805	--	
Cameron	7,441	--	
Camp	8,668	W	Clays.
Carson	112,056	--	
Cass	52,211	W	Iron ore.
Chambers	267,292	W	Salt, sand and gravel, clays.
Cherokee	8,981	W	Clays.
Childress	133	--	
Clay	16,913	--	
Cochran	169,270	--	
Coke	43,806	W	Sand and gravel.
Coleman	9,173	W	Stone, clays.
Collin	W	W	Stone.
Collingsworth	4,011	--	
Colorado	110,876	35,395	Sand and gravel.
Comal	W	W	Stone, lime, sand and gravel.
Comanche	1,469	W	Stone, clays.
Concho	3,669	192	Stone.
Cooke	57,134	W	Sand and gravel, stone.
Coryell	W	W	Stone, sand and gravel.
Cottle	4,670	--	
Crane	439,263	--	
Crockett	141,428	420	Stone.
Crosby	3,121	W	Sand and gravel, stone.
Culberson	85,235	W	Sulfur (Frasch), talc, stone.
Dallam	W	--	
Dallas	W	W	Cement, sand and gravel, stone, clays.
Dawson	101,168	--	
Deaf Smith	W	W	Lime.
Denton	2,660	1,426	Sand and gravel, clays.
De Witt	37,923	--	
Dickens	2,331	--	
Dimmit	58,812	--	
Donley	W	--	
Duval	84,835	W	Uranium, salt, sand and gravel.
Eastland	11,847	W	Clays, stone, sand and gravel.
Ector	794,419	W	Cement, stone.
Edwards	8,313	--	
Ellis	W	W	Cement, stone, clays.
El Paso	W	W	Cement, stone, sand and gravel.
Erath	1,390	--	
Falls	221	--	
Fannin	W	W	Sand and gravel.
Fayette	3,965	W	Clays, sand and gravel.
Fisher	83,002	W	Gypsum, clays.
Foard	2,440	--	
Fort Bend	158,643	15,761	Sulfur, salt, clays, sand and gravel.
Franklin	39,363	--	
Freestone	31,927	W	Stone, clays.
Frio	54,065	W	Stone.
Gaines	469,391	W	Sodium sulfate, stone.
Galveston	162,829	W	Sand and gravel, clays.
Garza	60,795	--	
Gillespie	W	W	Gypsum, stone, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Glasscock	$43,331	--	
Goliad	27,586	--	
Gonzales	3,545	--	
Gray	90,534	W	Sand and gravel.
Grayson	57,434	$589	Stone.
Gregg	471,031	478	Sand and gravel.
Grimes	214	30	Stone.
Guadalupe	14,768	W	Clays, sand and gravel.
Hale	70,102	--	
Hall	W	263	Sand and gravel.
Hamilton	414	--	
Hansford	56,310	W	Stone.
Hardeman	7,719	W	Gypsum.
Hardin	40,683	W	Sand and gravel.
Harris	476,742	99,177	Cement, sand and gravel, salt, lime, clays, stone.
Harrison	31,904	W	Clays, sand and gravel.
Hartley	W	--	
Haskell	18,647	--	
Hays	1,169	1,852	Sand and gravel.
Hemphill	148,618	--	
Henderson	36,948	W	Sand and gravel, clays.
Hidalgo	107,558	W	Stone, sand and gravel.
Hill	4,604	W	Lime, stone.
Hockley	418,329	352	Stone.
Hood	491	W	Do.
Hopkins	20,818	--	
Houston	21,488	W	Sand and gravel.
Howard	162,461	W	Sand and gravel, stone.
Hudspeth	W	W	Talc, stone, gypsum.
Hunt	442	19	Stone.
Hutchinson	206,261	W	Sand and gravel, salt.
Irion	31,745	--	
Jack	37,176	W	Stone.
Jackson	191,777	--	
Jasper	6,518	--	
Jefferson	105,948	W	Sulfur (Frasch), sand and gravel, salt.
Jim Hogg	22,205	--	
Jim Wells	202,596	W	Stone.
Johnson	W	W	Lime, stone, sand and gravel.
Jones	16,101	329	Sand and gravel, stone.
Karnes	52,829	W	Uranium, stone.
Kaufman	3,988	1,280	Stone.
Kenedy	65,003	--	
Kent	119,426	4	Sand and gravel.
Kerr	W	W	Sand and gravel, stone.
Kimble	1,551	149	Do.
King	36,946	--	
Kleberg	439,393	--	
Knox	7,149	--	
Lamar	--	W	Sand and gravel.
Lamb	W	W	Stone.
Lampasas	127	341	Stone, sand and gravel.
La Salle	5,488	264	Stone.
Lavaca	45,729	--	
Lee	1,877	--	
Leon	4,197	--	
Liberty	70,025	W	Sulfur (Frasch), sand and gravel.
Limestone	12,193	W	Clays, sand and gravel, stone.
Lipscomb	36,201	--	
Live Oak	42,751	W	Uranium, sand and gravel.
Llano	W	575	Stone, vermiculite.
Loving	46,297	--	
Lubbock	5,175	W	Sand and gravel, stone.
Lynn	1,703	W	Stone.
McCulloch	5,342	7,921	Sand and gravel, stone.
McLennan	19,708	24,536	Cement, sand and gravel, stone, clays.
McMullen	29,064	702	Stone.
Madison	8,793	--	
Marion	7,426	W	Clays.
Martin	107,430	--	
Mason	22	111	Stone.
Matagorda	140,289	W	Salt, stone.
Maverick	14,129	W	Sand and gravel.
Medina	2,837	W	Sand and gravel, clays, stone.
Menard	1,923	--	
Midland	145,492	W	Stone.
Milam	9,220	--	
Mills	166	12	Stone.
Mitchell	43,633	W	Sand and gravel.
Montague	25,348	W	Stone, sand and gravel.
Montgomery	238,523	W	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Moore	$227,919	W	Helium.
Morris	W	W	Iron ore.
Motley	2,856	W	Sand and gravel, stone.
Nacogdoches	20,755	W	Iron ore, clays, stone.
Navarro	17,762	W	Clays, stone.
Newton	9,014	W	Sand and gravel.
Nolan	60,493	$25,324	Cement, gypsum, stone, sand and gravel.
Neuces	199,240	W	Cement, lime, sand and gravel.
Ochiltree	69,683	--	
Oldham	4,496	1,268	Sand and gravel, stone.
Orange	20,892	W	Cement, sand and gravel, clays.
Palo Pinto	33,089	W	Clays, sand and gravel.
Panola	79,239	--	
Parker	23,061	W	Stone, sand and gravel, clays.
Pecos	801,784	W	Sulfur (Frasch), sand and gravel.
Polk	25,945	126	Sand and gravel.
Potter	83,641	11,552	Cement, stone, sand and gravel, clays.
Presidio	W	W	Sand and gravel.
Rains	3,224	--	
Randall	W	802	Stone.
Reagan	113,977	--	
Red River	174	--	
Reeves	110,358	W	Sand and gravel.
Refugio	391,949	--	
Roberts	49,821	--	
Robertson	78	--	
Runnels	16,071	W	Sand and gravel.
Rusk	182,594	W	Clays.
San Jacinto	3,001	--	
San Patricio	83,750	W	Stone, clays.
San Saba	W	W	Stone.
Schleicher	25,466	--	
Scurry	976,187	W	Magnesium chloride.
Shackleford	30,874	--	
Shelby	2,985	--	
Sherman	42,439	--	
Smith	39,504	W	Sand and gravel, stone, clays.
Somervell	1,377	W	Sand and gravel.
Starr	89,653	W	Do.
Stephens	43,016	W	Stone.
Sterling	20,698	--	
Stonewall	46,941	W	Gypsum, stone.
Sutton	54,302	2,098	Stone.
Swisher	48	--	
Tarrant	W	W	Cement, sand and gravel, stone.
Taylor	25,651	W	Stone, sand and gravel, clays.
Terrell	26,034	--	
Terry	104,804	W	Sodium sulfate.
Throckmorton	13,987	--	
Titus	39,643	--	
Tom Green	21,187	W	Stone.
Travis	12,221	W	Lime, sand and gravel, stone.
Trinity	46	--	
Tyler	10,449	--	
Upshur	29,253	246	Sand and gravel.
Upton	179,208	--	
Uvalde	16,456	W	Stone, asphalt, sand and gravel.
Val Verde	3,652	W	Sand and gravel.
Van Zandt	168,681	W	Salt, clays.
Victoria	63,894	6,092	Sand and gravel.
Walker	814	W	Stone, clays, sand and gravel.
Waller	244,260	19	Sand and gravel.
Ward	269,228	W	Sand and gravel, salt.
Washington	1,263	--	
Webb	68,141	W	Uranium, sand and gravel, stone.
Wharton	125,490	W	Sulfur (Frasch).
Wheeler	58,823	--	
Wichita	54,391	W	Sand and gravel, stone.
Wilbarger	26,310	--	
Willacy	28,402	--	
Williamson	7,864	10,657	Stone, sand and gravel.
Wilson	5,854	W	Clays, stone.
Winkler	268,713	--	

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Wise	$125,208	W	Stone, sand and gravel, clays.
Wood	448,385	W	Clays, sand and gravel.
Yoakum	884,187	W	Salt.
Young	28,481	W	Stone, sand and gravel.
Zapata	31,569	--	
Zavala	8,124	--	
Undistributed[2]	258,059	$19,134,443	
Total[3]	[r]18,143,209	19,519,631	

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Bandera, Blanco, Briscoe, Castro, Delta, Floyd, Jeff Davis, Kendall, Kinney, Parmer, Real, Rockwall, Sabine, and San Augustine.

[2] Includes coal, petroleum, natural gas, and natural gas liquids in 1977 that cannot be assigned to specific counties, uranium ore, gem stones, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Texas business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	5,578.0	5,786.0	+3.7
Unemployment	do	320.0	310.0	-3.1
Employment (nonagricultural):				
Mining	do	139.9	155.1	+10.9
Manufacturing	do	862.3	896.5	+4.0
Contract construction	do	320.4	340.6	+6.3
Transportation and public utilities	do	294.3	309.0	+5.0
Wholesale and retail trade	do	1,161.4	1,199.6	+3.3
Finance, insurance, real estate	do	258.7	273.5	+5.7
Services	do	799.7	837.3	+4.7
Government	do	847.0	860.3	+1.6
Total nonagricultural employment	do	4,683.7	4,871.9	+4.0
Personal income:				
Total	millions	$77,682	$87,280	+12.4
Per capita		$6,166	$6,803	+10.3
Construction activity:				
Number of private and public residential units authorized		97,270	136,212	+40.0
Value of nonresidential construction	millions	$1,482.1	$1,900.8	+28.2
Value of State road contract awards	do	$440.0	$440.0	--
Shipments of portland and masonry cement to and within the State	thousand short tons	6,663	8,117	+21.8
Mineral production value:				
Total crude mineral value	millions	[r]$18,143.2	$19,519.6	+7.6
Value per capita, resident population		$1,453	$1,521	+4.7
Value per square mile		$67,866	$73,015	+7.6

[p]Preliminary. [r]Revised.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Legislation and Government Programs.—The 65th Texas Legislature passed a bill granting to the Texas Railroad Commission (TRRC) the authority to issue permits for construction and operation of coal slurry pipelines. The bill gives companies the right to eminent domain but denies the use of Texas water in slurry pipelines.

Another bill brings the Texas Surface Mining and Reclamation Act under the Administrative Procedure and Texas Register Act. The law broadened the definition of surface mining to include in situ mining of coal, but excluded uranium in situ mining from regulation by the TRRC.

The legislature created a Natural Resource Council to advise the Governor and legislature on natural resource issues. The council, chaired by the Governor, is to coordinate all natural resources policy for the State and provide a channel of communication between the various State agencies concerned with administering air, energy, and water laws. A companion bill directs this Natural Resource Council to report to the Governor and legislature on coastal problems and designates the Governor to report on the efforts of the State in seeking certification under the Federal Coastal Zone Management Act of 1972.

The Texas Energy Development Act of 1977 created an Energy Development Fund of $1.5 million to support research in the development of solar, geothermal, lignite, biomass, wind, conservation, and other alternate energy resource technologies. This fund, which could ultimately amount to $5 million, will be administered by a board within the Texas Energy Advisory Council. The board will be responsible for reviewing all proposals, letting of contracts and grants, and monitoring the approved research programs.

Texas became the first State to ratify an interstate compact between Texas, Arkansas, Louisiana, New Mexico, and Oklahoma for the purpose of conservation, use, and exchange of energy and water among the member States. Upon ratification of two or more States, the Interstate Compact for Conservation and Utilization of Natural Energy and Water Resources goes into effect, in accordandce with the Federal law creating an Interstate Natural Energy and Water Resource Commission.

In a special legislative session, Texas lawmakers authorized creation of a deepwater port authority, which can issue bonds to construct a port off the Texas coast. Seadock, Inc., a private consortium that had been formed to build the port, appeared to be virtually dead. The law prohibits the State of Texas from guaranteeing payment of the revenue bonds and exempts the State from liability for damages such as oil spills.

The TRRC Surface Mining Div. adopted regulations prohibiting open pit mining within a distance of one times the depth of the pit, but in no instances less than 100 feet from a major pipeline. The rule provides for variances if the mining operator and the pipeline owner agree to the exceptions and the TRRC approves.

On August 3, 1977, the President signed the Federal Surface Mining Control and Reclamation Act of 1977 (Public Law 95-87) that provides for cooperation between the Secretary of the Interior and the States with respect to the regulation of surface coal mining operations, and the acquisition and reclamation of abandoned mines, and for other purposes. The State of Texas, acting through the TRRC, announced that changes in the Texas Surface Mining and Reclamation Rules and Regulations would be made to allow the State to administer the new Federal law.

The Texas Supreme Court, in a landmark decision affecting lignite ownership, ruled that the surface owner of land is the owner of lignite extracted by strip mining. The court reaffirmed its 1971 ruling that the owner of the surface is the owner of near-surface minerals such as iron ore, sand and gravel, and limestone, that must be mined by surface methods which substantially destroy or deplete the surface estate. This decision is almost certain to invoke further test cases to clear ownership where surface and mineral estates have been separated and where mining by underground methods may not adversely affect the surface owners estate.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The value of mineral fuels production, except coal, totaled $18,362 million, an increase of 7% compared with the value in 1976. Crude oil production was 1,138 million barrels in 1977, down 52 million barrels from an output of 1,190 million barrels in 1976. The average wellhead value of crude oil was $8.59 per barrel in 1976. Crude oil was the State's top value contributor in 1977 yielding $9,986 million or 51% of the State's total mineral value.

In 1977, natural gas output was 7,051 billion cubic feet (MMMcf) compared with an output of 7,192 MMMcf in 1976. Average unit value of natural gas was 90.3 cents per thousand cubic feet (Mcf), up 18.5 cents per Mcf over the 1976 value of 71.8 cents per Mcf. Total value of natural gas production in 1977 was $6,367 million.

The output of natural gas liquids was 284 million barrels in 1977 valued at $2,009 million. Comparable figures for 1976 were 287 million barrels and $1,784 million, respectively.

Coal (lignite) production was up over the 1976 production. Output was from five strip mines in Freestone, Harrison, Milam, Panola, and Titus Counties. More than 97% of the lignite production was consumed for fuel in mine-mouth steam-electric powerplants. The remainder was used in manufacturing activated charcoal.

NONMETALS

Barite.—No barite was mined in Texas in 1977, but six companies operating eight grinding plants processed 704,112 tons of imported crude barite. Total value of the ground barite was $34.8 million. Average value was $49.42 per ton compared with $45.17 per ton in 1976. Over 95% of the material was used as a weighting agent for well-drilling muds.

Cement.—Increased construction activity and new housing starts were responsible for a gain of 11% in the production of portland cement in 1977. Production was 8,233,151 tons, an increase of 795,260 tons over the 1976 output of 7,437,891 tons. Texas continued to rank second among the States in cement production in 1977.

Sales of portland cement rose 15% to 8,481,600 tons, exceeding the State's total production in 1977 by 248,449 tons. The difference in cement output and sales was made up by importing 262,305 tons and reducing stocks onhand at the beginning of the year. Foreign imports were from the United Kingdom, Mexico, and Spain.

Table 4.—Texas: Portland cement salient statistics

(Short tons)

	1976	1977
Number of active plants	18	18
Production	7,437,891	8,233,151
Shipments from mills:		
Quantity	7,387,715	8,481,600
Value	$271,065,798	$331,757,683
Stocks at mills, Dec. 31	542,782	342,899

Table 5.—Texas: Masonry cement salient statistics

(Short tons)

	1976	1977
Number of active plants	12	12
Production	220,342	259,199
Shipments from mills:		
Quantity	212,922	253,536
Value	$10,595,637	$13,095,171
Stocks at mills, Dec. 31	19,154	15,725

Average value per ton of portland cement in 1977 was $39.11 compared with $36.69 per ton in 1976, an increase of 7%. Total value of portland cement sales was $331.8 million.

Thirteen companies operated 18 cement plants in Bexar (3 plants), Dallas (1 plant), Ector (1 plant), Ellis (2 plants), El Paso (1 plant), Harris (4 plants), McLennan (1 plant), Nolan (1 plant), Nueces (1 plant), Orange (1 plant), Potter (1 plant), and Tarrant (1 plant) Counties. In April, General Portland, Inc., shut down its Houston cement plant but continued to use the plant's facilities as a shipping and receiving terminal. Texas Industries, Inc., applied for permits to build a new 550,000-ton-per-year cement plant near Hunter in Comal County. The $80 million plant will be a coal-fired, dry process, preheater facility scheduled to go on-stream in late 1979. The Texas Cement Co., a subsidiary of Centex Corp., continued construction of a new cement plant near Buda in Hays County. The plant, with a rated capacity of about 470,000 tons per year, is scheduled to begin production in mid-1978. The $32 million plant is a dry process, preheater facility that will burn coal as a primary fuel.

Masonry cement was produced by 10 companies at 12 plants in 1977. Production rose 18% above the previous year's output.

Average value of masonry cement was $51.65 per ton compared with $49.76 per ton in 1976.

A total of 30.7 MMMcf of natural gas and 42,000 barrels of fuel oil were consumed as fuel for the production of cement in 1977. Nine cement plants reported burning some coal in 1977 compared with six plants in 1976. The consumption of coal and coke for fuel to produce cement was up 300%.

Clays.—For the first time since 1973, Texas experienced a rise in total clay production. Although the increase was small, less than 1%, the value was up 19% over the previous year's output. Average value per ton was $4.27, up from $3.62 per ton in 1976. Types of clay produced included ball clay, bentonite, fuller's earth, kaolin, and common clay and shale.

Forty-four companies operated 93 clay mines in 40 Texas counties. Leading clay productive counties were Bexar, Eastland, Fort Bend, Harris, and Rusk. These five counties contributed about 35% of the State's total clay output.

Bentonite was mined in Fayette and Walker Counties by E. A. Holly Co. and Milwhite Co., Inc. The bentonite was used principally in drilling muds.

In 1977, common clay and shale accounted for 94% of the State's total clay output. Production declined slightly from 3,597,000 tons to 3,586,000 tons, but value rose from $7.6 million to $10.2 million. Output was reported by 38 companies operating 84 clay mines in 37 counties. Common clay and shale was used principally in the manufacture of portland cement, the production of lightweight aggregate, and in building brick. Other uses included sewer pipe and structural and quarry tile.

Texas Industries, Inc., purchased the large lightweight aggregate plant near Streetman in Navarro County from Superock, Inc. This plant replaced lost production from the company's Eastland lightweight aggregate plant that was closed because of obsolescence and environmental problems.

In June, Texas Industries, Inc., converted their large Clodine lightweight aggregate plant in Fort Bend County to burn coal instead of natural gas. The company also will convert the Streetman plant to burn coal in early 1978.

Fire clay production increased 4% and value rose 7% in 1977. Elgin-Butler Brick Co. (Bastrop County), General Refractories Co. (Cherokee County), Texas Clay Products, Inc. (Henderson County), and A. P. Green Refractories Co. (Wood County) operated open pit mines producing fire clay. The production was used principally in the manufacture of firebrick and block.

Balcones Minerals Corp. produced fuller's earth from clay mines in Fayette County. Production was slightly above 1976 output. Fuller's earth was used mainly as an absorbent.

Kaolin was mined by Dresser Industries, Inc., and General Portland, Inc., from clay pits in Limestone County. Total production was 28% above the previous year's output. Kaolin was used in the manufacture of paints, fertilizer, fiberglass, white portland cement, rubber, and other products.

In response to a strong demand for building brick, Acme Brick Co. began a $1.1 million expansion program at its plant in Nacogdoches County. The expansion, designed to double the plant's capacity, will include a new dryer, two new kilns, and a conveyor system. Acme Brick Co. also began a $1 million expansion at the company's McQueeney plant in Guadalupe County that will double the brick capacity and improve production and energy efficiencies.

Fluorspar.—D & F Minerals Co. produced metallurgical-grade fluorspar from both open-pit and underground mining operations in Brewster County. Output was up 22% and value increased 23% over 1976.

Fluorspar, imported from the Republic of Mexico, was processed at plants in Brownsville, Eagle Pass, and Marathon.

Table 6.—Texas: Clays sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Year	Ball clay		Bentonite		Fire clay		Common clay and shale		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1973	W	W	85	802	87	689	5,330	8,951	5,667	13,115
1974	41	329	69	881	41	316	5,046	8,365	5,315	13,677
1975	55	467	W	W	34	271	3,995	7,594	4,248	13,411
1976	16	109	39	850	54	260	3,597	7,628	[2]3,706	[2]8,847
1977	W	W	40	974	56	278	3,586	10,213	[2]3,682	[2]11,465

W Withheld to avoid disclosing company proprietary data.

[1] Includes fullers earth, kaolin, and data indicated by symbol W.

[2] Excludes ball clay, fuller's earth (1976), and kaolin (1976).

Gem Stones.—Rock and mineral specimens, with an estimated total value of $160,000, were collected by dealers and hobbyists. Agate, jasper, opal, quartz, topaz, fluorite, calcite, cinnabar, petrified wood, and fossiliferous limestone were among the minerals and rocks that were collected.

Graphite.—Southwestern Graphite Co., a division of Joseph Dixon Crucible Co., recovered small-flake crystalline graphite from a graphitic schist mined in Burnet County. This open pit operation continued to be the only active graphite mine in the United States. In 1977, production declined 13% and value of sales dropped 12% below 1976 levels.

Natural graphite was used in crucibles and foundry facings, as a dry lubricant, and in pencils and other products.

Gypsum.—Production of crude gypsum in Texas reached a record high of 1,718,222 short tons in 1977, exceeding the previous record set in 1973 by 6%. Average price was $5.14 per ton compared with $4.13 per ton the previous year. Value of total production was $8,836,674, an increase of 40% over the 1976 value.

Seven companies reported production from seven quarries in six Texas counties — The Celotex Corp. in Fisher County, Fredericksburg Gypsum Co. in Gillespie County, Georgia-Pacific Corp. in Hardeman County, Southwestern Portland Cement Co. in Hudspeth County, Flintkote Co. and United States Gypsum Co. in Nolan County, and National Gypsum Co. in Fisher County.

Most of the crude gypsum was calcined for use in the production of building products such as wallboard and plaster in plants located in Fisher, Hardeman, Harris, and Nolan Counties. Crude gypsum was also used as a retarder in portland cement, as a filler, and as a soil conditioner.

Helium.—Texas ranked third in production of crude helium in 1977. Output was 9 million cubic feet (MMcf), a decrease of 3 MMcf from 12 MMcf of production in 1976.

Lime.—Texas lime output in 1977 increased for the first time since 1974 to 1,612,000 short tons or 11% above the previous year's production. Total value was $49.965 million; a 14% gain over the value in 1976. Texas moved from fifth to fourth ranked State in lime output with 8% of the total U.S. production. Approximately 58% of the total lime produced was hydrated lime and the remainder was quicklime.

Lime plants were operated in 10 counties by 11 companies. The three leading producers were PPG Industries, Inc. (Nueces County), Texas Lime Co. (Johnson County), and United States Gypsum Co. (Comal County).

Table 7.—Texas: Lime sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Soil stabilization	490	13,570	510	14,981
Water purification	109	3,196	222	7,113
Steel, electric	103	3,313	154	4,951
Aluminum and bauxite	123	3,975	127	4,059
Paper and pulp	149	4,727	90	2,871
Sewage treatment	17	481	18	585
Oil well drilling	17	513	15	494
Mason's lime	14	385	15	448
Acid mine water	13	375	W	W
Petroleum refining	6	180	6	208
Other uses[1]	416	13,269	455	14,256
Total[2]	1,455	43,983	1,612	49,965

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes alkalies, open-hearth steel furnaces, chrome, sugar refining, petrochemicals, magnesium agriculture, other construction lime, other metallurgy, glass, insecticides, paint, food and food byproducts, copper ore concentration, rubber, other chemical uses, tanning (1977), wire drawing, sulfur removal (1976), finishing lime (1976), and uses indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

The leading uses of lime were soil stabilization (32%), purification of water (14%), steel production (10%), and preparation of alumina (8%).

Perlite (Expanded).—In 1977, perlite mined outside of Texas was processed by seven companies operating plants in Bexar, Dallas, Comal, Harris, and Nolan Counties.

Output of expanded perlite decreased 8% during the year and value declined 4%. The expanded material was used as filter media, in construction aggregates, horticulture aggregates, and for insulation purposes.

Salt.—Production of salt was 10.9 million tons, up 13% over the 1976 output of 9.7 million tons. The increase in demand for salt reflects the growth of the chemical and other salt consuming industries. In 1977, Texas ranked second in total salt production accounting for 25% of the Nation's total output.

Table 8.—Texas: Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1973	10,354	45,350
1974	11,379	51,296
1975	8,560	42,119
1976	9,718	48,875
1977	10,941	53,264

Nine companies produced salt in brine from wells in Brazoria, Chambers, Duval, Fort Bend, Harris, Hutchinson, Jefferson, Matagorda, Van Zandt, Ward, and Yoakum Counties. Two of these companies also produced rock salt from underground mines in Harris and Van Zandt Counties.

Sand and Gravel.—Total consumption of sand and gravel in Texas was up 16% and use of sand and gravel as concrete aggregate was 31% higher than in 1976. Expanded construction activity brought about some spot shortages and inflationary pressures resulted in an 11% increase in average value per ton of sand and gravel. Average unit price was $2.40 per ton in 1977 compared with $2.16 per ton in 1976.

Texas ranked third in output of construction sand and gravel with 53.9 million tons valued at $119.1 million. Total output of sand and gravel was 55.5 million tons valued at $133.4 million. Production of sand and gravel was reported by 190 operators from 226 pits in 91 counties. Gifford-Hill & Co., Inc., Lone Star Industries, Thorstenberg Materials, Texas Industries, Inc., and Parker Bros. & Co., Inc., were the leading producers of sand and gravel accounting for about 30% of the State's total output. Colorado, Dallas, Victoria, Tarrant, and Harris were the leading sand and gravel productive counties accounting for over 50% of the State's total output.

In 1977, production of industrial sand and gravel was 1.6 million tons compared with 1.3 million tons the previous year. Average value per ton was $8.99, up sharply from $6.83 per ton in 1976. Dresser Industries, Inc., Texas Mining Co., and Pennsylvania Glass Sand Corp. were the principal producers of industrial sand in 1977.

Sodium Sulfate (Natural).—Sodium sulfate, contained in alkali-lake-bed brines, was extracted by Ozark-Mahoning Co. in Gaines and Terry Counties. Output from the company's two plants was down 2% but value increased about 2% in 1977. Sodium sulfate was used in the manufacture of paper, detergents, glass, dyes, and other products.

Stone.—Increased construction activity was the significant factor that boosted Texas crushed stone production 19% to 65.4 million tons in 1977. Value of shipments was $122.8 million, an increase of 23% over the previous year. Texas became the leading producer of crushed stone among the States, advancing from third place in 1976. In 1977, Texas also ranked second in output

Table 9.—Texas: Sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	29,236	$57,285	$1.96
Gravel	24,662	61,784	2.51
Total or average	53,898	119,069	2.21
Industrial:			
Sand	1,582	14,274	9.02
Gravel	16	77	4.81
Total or average	[1]1,597	14,351	8.99
Grand total or average	55,495	133,420	2.40

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[1] Data do not add to total shown because of independent rounding.

Table 10.—Texas: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	31,531	$73,869	$2.34
Concrete products	5,991	14,898	2.49
Asphaltic concrete	5,733	12,685	2.21
Roadbase and coverings	4,636	9,264	2.00
Fill	5,771	7,861	1.36
Railroad ballast	W	W	1.75
Other uses	208	443	2.13
Total	53,898	119,069	2.21

W Withheld to avoid disclosing company proprietary data; included in "Total."

of shell and marl, and fifth in dimension and crushed marble.

Crushed stone production was reported from 219 quarries by 88 companies. Leading producers were Texas Crushed Stone Co., Parker Bros. & Co., Inc., and McDonough Bros., Inc. The five leading counties in production of crushed stone were Bexar, Wise, Williamson, Comal, and Ellis. Ninety-four percent of the crushed stone production was limestone, the other 6% was composed of crushed granite, marble, marl, sandstone, shell, and traprock.

Crushed stone used as concrete aggregate increased almost 44% during the year reflecting the increase in construction activity in the State. The amount of limestone used in cement manufacture rose slightly. Output of crushed limestone, marl, sandstone, and shell increased in 1977, whereas crushed granite, marble, and traprock declined.

Most of the dimension stone, consisting of limestone, granite, and marble, was obtained from quarries in Burnet, Gillespie, Jones, Llano, Mason, and Williamson Counties. Production increased 87% to 27,298 tons valued at $3.9 million, an increase of almost 114% over that of 1976. The dimension stone produced in Texas was prepared as rough and cut stone for use in buildings, facings, foundations, and retaining walls, and for monuments and gravestones.

Table 11.—Texas: Crushed stone[1] sold or used producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	22,020	33,220	27,170	40,410
Concrete aggregate	6,737	14,130	9,681	21,200
Cement manufacture	8,572	12,330	8,866	12,300
Roadstone	4,730	8,293	4,313	7,958
Surface treatment aggregate	3,221	7,888	4,309	10,290
Bituminous aggregate	3,386	9,969	4,135	13,890
Lime manufacture[2]	2,004	3,960	2,221	4,415
Railroad ballast	1,253	2,162	1,147	2,307
Flux stone	298	730	825	1,581
Riprap and jetty stone	533	1,222	547	1,249
Agricultural limestone	348	558	371	564
Waste material	W	W	274	321
Other filler	147	820	168	877
Mineral food	101	407	151	528
Roofing granules	201	652	148	785
Macadam aggregate	129	181	W	W
Terrazzo and exposed aggregate	116	948	107	1,308
Filter stone	W	W	97	160
Mine dusting	56	112	W	W
Other uses[3]	984	2,233	914	2,641
Total[4]	54,841	99,816	65,446	122,784

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, shell, sandstone, marl, marble, traprock, and granite.

[2] Includes stone used in chemical stone for alkali works and sugar refining.

[3] Includes stone used in chemicals, whiting, asphalt filler, sulfur dioxide (1976), unspecified uses, and uses indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Table 12.—Texas: Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1973	4,294	4,109	W
1974	4,593	4,473	W
1975	4,141	3,406	W
1976	3,777	3,415	W
1977	3,400	3,480	W

W Withheld to avoid disclosing company proprietary data.

Sulfur.—Native sulfur production from Frasch mines declined for the third consecutive year. Production was 3.4 million long tons down from 3.8 million long tons, or about 10% below that of 1976. Value of sulfur shipments, however, fell less than 1%. Frasch sulfur was produced from four mines in the gulf coastal area of the State and three mines in west Texas. Producers of Frasch sulfer were Texasgulf, Inc. (Fort Bend, Jefferson, Liberty, Pecos, and Wharton Counties), Jefferson Lake Sulfur Co. (Fort Bend County), Duval Corp. (Culberson County), and Farmland Industries, Inc. (Pecos County).

Texasgulf, Inc., closed its 19-year-old Fannett sulfur mine in Jefferson County in March. Increases in production costs plus depleting reserves were among the reasons for the closure. Cumulative sulfur production from the Fannett mine was almost 3.5 million long tons.

Elemental sulfur was extracted from natural gas and crude oil at 56 operations in 30 counties. Harris, Van Zandt, Jefferson, and Cass Counties accounted for 57% of the recovered sulfur produced. Sales of recovered sulfur from Texas plants were up 13% above 1976 sales to 981,986 long tons and value of sales increased 13%. Average value per ton remained relatively the same at $39.42 compared with $39.44 per ton in 1976.

Talc.—Texas advanced from fourth to second among the States in talc production in 1977. Output totaled 233,024 tons valued at $2.2 million. Production of crude talc was up 17% and value gained 105% over that of 1976. Five companies operated 12 mines in Culberson and Hudspeth Counties in west Texas. The material was used in the preparation of paint, ceramics, insecticides, roofing, textiles, and other products.

Vermiculite.—Crude vermiculite was mined and exfoliated by Volite, Inc., in Llano County. This was the first crude vermiculite production reported in Texas since 1969.

Imported vermiculite was exfoliated at plants in Bexar, Dallas, and Harris Counties for use as concrete and plaster aggregate, loose fill and block insulation, soil conditioner, and fireproofing. Total vermiculite sales rose 21% and value increased 16% over 1976 levels. Average value per ton declined 4%.

METALS

Iron ore, magnesium chloride, and uranium were the only raw metallic minerals mined in Texas in 1977. Although not mined in the State, aluminum, antimony, cadmium, copper, gold, lead, manganese, silver, tin, tungsten, and zinc were recovered at smelters, refineries, and reduction plants. Metal scrap and other secondary materials were also processed for reuse at a number of metal recovery facilities.

Aluminum.—Texas regained its 2d place national standing in the production and value of primary aluminum after a 2-year decline in 1975 and 1976. Bauxite imported from out-of-State sources was processed at alumina refineries near Corpus Christi and Point Comfort. The alumina was reduced to metal in the State's four smelters located near Corpus Christi, Point Comfort, Rockdale, and Palestine, Tex. Production of aluminum metal increased 47% and value increased 70% over that of 1976.

Antimony.—ASARCO, Incorporated, completed a $7.5 million antimony recovery unit at the company's El Paso smelter. The new plant has the capacity to produce 5 tons of 99.5% pure antimony metal per day. NL Industries, Inc.'s antimony smelter in Laredo was shutdown in mid-November 1977. The smelter, which has been in operation since 1930, treated imported ores principally from the Republic of Mexico.

Cadmium.—Cadmium was recovered as a byproduct of zinc smelting at ASARCO's electrolytic plant at Corpus Christi. Output was down 75% and value dropped 72%.

Copper.—Copper ores and concentrates were imported into the State and smelted at the metallurgical works of ASARCO in El Paso.

Iron Ore.—Brown iron ore (limonite and siderite), mined from open pits in Cass, Morris, and Nacogdoches Counties, was used in the production of pig iron, cement, as an animal feed supplement and a weighting agent in well drilling fluids, and for other uses. In 1977, iron ore production and value increased over that of 1976.

Lead.—ASARCO recovered lead from ores and concentrates imported from other States and the Republic of Mexico at the company's smelter in El Paso.

Magnesium.—Magnesium chloride was recovered from seawater and from subsurface brine for the production of magnesium compounds and magnesium metal. Production of magnesium metal dropped slightly during the year but the value of shipments rose 20%. Both quantity and value of shipments of magnesium compounds were up over 1976 levels.

Manganese.—Silicomanganese and ferromanganese were produced by Tenn-Tex Alloy Corp. of Houston. Feedstocks were imported.

Silver and Gold.—These precious metals were recovered as byproducts at ASARCO's electrolytic copper refinery in Amarillo.

Late in the year, some exploration work was underway at several prospects in Hudspeth and Presidio Counties for metalliferous ores that contain silver and trace amounts of gold.

Tin.—The only tin smelter in the United States continued to be operated by Gulf Chemical & Metallurgical Corp. in Texas City. Most of the feedstock was imported from Bolivia.

One company was assembling leases and making plans to evaluate a tin prospect in the Franklin Mountains in El Paso County.

Uranium.—Texas uranium production, fifth ranked in the Nation, was 83% higher and unit value was 125% above 1976 levels. Most of the increase in average price per pound can be attributed to sales from new operations whose production contracts call for considerably higher prices than the uranium that was sold under delivery contracts negotiated some 8 to 10 years ago.

Stimulated by higher uranium prices and favorable results from in situ leach projects, the uranium industry responded with a record exploration and development drilling program in 1977. Twenty-nine companies and individuals drilled a total of 5.6 million feet, an increase of 93% over the 2.9 million feet drilled in 1976.

In December, Continental Oil Co. completed a mill expansion program that increased the rated capacity of the Conquista facility from 1,750 to 2,900 tons of ore per day. The mill is expected to recover about 1.5 million pounds of uranium per year. Conoco began extracting ore from the Rosenbrock mine in Karnes County setting a new depth record for open pit mining in Texas at 285 feet. In March, Conoco applied to the Surface Mining Div. of the TRRC for mining permits for 32 new surface mines. None of the permits had been approved at yearend.

Exxon Minerals Co. received approval from the Surface Mining Div. of the TRRC to reopen the Felder-McLean uranium mining properties in Live Oak County that have been closed since 1971. Ore from the Felder-McLean open pit mines will be processed at Conoco's Conquista mill.

Chevron Resources mining permit for the Panna Maria project in Karnes County was approved by the Surface Mining Div. of the TRRC in July. Construction was begun on a 3,000-ton-per-day conventional acid leach mill near the community of Panna Maria. Overburden from the company's initial open pit mine was used in the construction of the mill tailings pond.

United States Steel Corp. assumed the operational management of the Burns in situ leach project in March and the Clay West in situ leach project in August. United States Steel and Niagra Mohawk purchased the uranium mines and plant facilities from Atlantic Richfield Co. and Dalco. United States Steel will increase the productive capacity of these projects from about 750,000 to 1.5 million pounds of yellowcake per year.

Wyoming Minerals completed construction of new plant facilities to convert the Lamprecht in situ leach project into a commercial-scale operation. The company also began completing development wells on the nearby Hahn uranium lease. The new plant and well field facilities, called the Sulfur Creek operation, will recover uranium from both the Hahn and Lamprecht sites. Wyoming Minerals continued to operate the Bruni in situ leach project in Webb County.

Mobil Oil Corp. expanded the O'Hern in situ leach project in Webb County. The company announced that the Holiday and El Mesquite uranium deposits in Duval County would be exploited by in situ leach mining and began drilling development wells on these sites. The Holiday and El

Mesquite deposits are about 5 miles north-northeast of the O'Hern project in Duval County.

Intercontinental Energy Corp. continued to operate the Pawnee in situ leach mine in Bee County. The company also began development drilling and construction of plant facilities at the Zamzow uranium deposit in Live Oak County.

Texura, Inc., was drilling development wells and making hydrological tests at a proposed pilot leach project on the Zunker and Lyssy leases in Karnes County.

Solution Engineering continued to construct plant and production facilities to solution mine and tailings at the abandoned Susquehanna-Western mill in Karnes County.

Union Carbide Corp. continued to drill development wells and recover uranium at the company's Palangana in situ mine during the year.

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[1] State Liaison Officer, Bureau of Mines, Austin, Tex.

[2] Research geologist, Bureau of Economic Geology, The University of Texas, Austin, Tex.

Table 13.—Texas: Smelters, refineries, and reduction plants in 1977

Product, company and plant	County	Material treated
Aluminum:		
Aluminum Co. of America:		
Point Comfort (alumina)	Calhoun	Bauxite.
Point Comfort (reduction)	do	Alumina.
Rockdale (reduction)	Milam	Do.
Anderson County (reduction)	Anderson	Do.
Reynolds Metal Co.:		
San Patricio (reduction)	San Patricio	Do.
Sherwin plant (alumina)	do	Bauxite.
Antimony:		
ASARCO Inc.:		
El Paso smelter	El Paso	Ore.
NL Industries, Inc.:		
Laredo smelter	Webb	Do.
Cadmium:		
ASARCO Inc.:		
Electrolytic	Nueces	Flue dust.
Copper:		
ASARCO Inc.:		
Amarillo refinery	Potter	Blister and anode.
El Paso smelter	El Paso	Ore and concentrates.
Phelps Dodge Refining Corp.:		
Nichols refinery	do	Blister and anode.
Iron:		
Armco Steel Corp.:		
Houston plant	Harris	Ore and scrap.
Lone Star Steel Co.:		
Daingerfield plant	Morris	Do.
United States Steel Corp.:		
Baytown plant	Chambers	Do.
Lead:		
ASARCO Inc.:		
El Paso smelter	El Paso	Ore and concentrates.
Magnesium:		
The Dow Chemical Co.:		
Freeport plants, electrolytic	Brazoria	Seawater.
American Magnesium Co.:		
Snyder plant, electrolytic	Scurry	Brine.
Manganese:		
Tenn-Tex Alloy Corp	Harris	Ore.
Sodium:		
Ethyl Corp	do	Salt.
Tin:		
Gulf Chemical & Metallurgical Corp.:		
Texas City smelter	Galveston	Ore.
Tungsten:		
Gulf Chemical & Metallurigical Corp.:		
Texas City smelter	do	Do.
Zinc:		
ASARCO Inc.:		
Corpus Christi, electrolytic	Nueces	Ore and concentrates.
El Paso, fuming plant	El Paso	Dusts and residues.

Table 14.—Texas: Secondary metal recovery plants

County and company	Material	Product
Austin:		
Schindler Bros. Steel Co	Steel scrap	Reinforced steel bars.
Bexar:		
Newell Salvage Co. of San Antonio	Scrap metal	Smelted and refined scrap metals.
Brazoria:		
Texas Reduction Corp	Aluminum scrap	Alloyed aluminum ingots.
Collin:		
Electro Extraction, Inc	Aluminum and copper scrap	Aluminum ingots, copper bars.
Gould, Inc	Lead scrap	Battery lead oxide, pig lead.
Dallas:		
Abasco, Inc	Aluminum scrap	Aluminum ingots, dioxidizing bars and shot.
ASARCO Incorporated	Lead and zinc scrap	Lead and zinc ingots, pigs, and alloys.
Dixie Metals Co	Lead scrap	Lead pigs, alloys, chemicals.
Laclede Steel Corp	Steel scrap	Reinforcing steel.
Murdock Lead Co., Div. RSR Corp	Lead scrap	Lead shot, solders, lead pipe.
NL Industries, Inc	Battery plates	Lead products.
Okon's Iron & Metal Co	Solder and lead scrap	Lead pigs and ingots.
El Paso:		
Border Steel Mills, Inc	Steel scrap	Reinforcing bars, bar shapes, steel grinding balls.
Proler International Corp	do	Precipitation iron.
SEC Corp	Nickel-copper waste solution	
Ellis:		
Chaparrall Steel Co	Steel scrap	Steel reinforcing bars and shapes.
Industrial Metals Co	Scrap metal	Metal shapes and ingots.
Gregg:		
Marathon-LeTourneau Co	Steel scrap	Steel castings and shapes.
Southwest Steel Castings Co	do	Steel castings.
Guadalupe:		
Structural Metals, Inc	do	Structural steel reinforcing bars.
Harris:		
A & B Metal Manufacturing Co. Inc	Scrap metal	Tungsten carbide.
Federated Metals Corp	Various metals	Lead ingot, solder, copper tubing, bearing metals, sheet lead, lead pipe.
Gulf Reduction Corp	Aluminum and zinc scrap	Aluminum, zinc ingots and alloys.
Houston Lead Co	Lead scrap	Lead pigs, ingots, alloys.
Lead Products Co., Inc	do	Do.
Newell Metals, Inc	Zinc scrap	Zinc dust.
Proler International Corp	Various metals	Zinc slab, aluminum alloys, precipitation iron.
Redgate, Virgil, Co	do	Recovery of gold, silver platinum, rhodium, copper, nickel, cadmium, aluminum.
Jefferson:		
Georgetown Texas Steel Corp	Steel scrap	Steel rods and shapes.
Laclede Steel Corp	do	Reinforcing steel.
Leon:		
Nucor Steel Co		
Smith:		
Bloch Metals, Inc	Aluminum scrap	Aluminum ingots.
Tyler Pipe Industries, Inc	Steel scrap	Pipe and pipe fittings.
Tarrant:		
National Metal & Smelting Co	Battery lead and aluminum scrap	Lead pigs, ingots, battery metal, aluminum ingots.
Texas Steel Co	Steel scrap	Carbon and alloy steel bars and shapes, reinforcing bars.

Table 15.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt (native):			
Uvalde Rock Asphalt Co	Box 531 San Antonio, TX 78206	Quarry and plant	Uvalde.
White's Mines, Inc	Box 499 San Antonio, TX 78206	do	Do.
Barite:			
Dresser Industries, Inc	Box 6504 Houston, TX 77002	Grinding plant	Cameron and Galveston.
Milwhite Co., Inc	Box 15038 Houston, TX 77020	do	Cameron and Harris.
NL Industries, Inc	Box 1675 Houston, TX 77001	do	Nueces.

Table 15.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Carbon black:			
Ashland Chemical Co	Box 1503 Houston, TX 77005	Furnace plant	Aransas and Wheeler.
Cabot Corp	125 High St. Boston, MA 02110	do	Gray and Howard.
Columbian Carbon Co., Div. of Cities Service Co.	3200 West Market Akron, OH 44313	do	Gaines and Montgomery.
Continental Carbon Co	Box 22085 Houston, TX 77027	do	Moore.
J. M. Huber Corp	Box 831 Borger, TX 79066	do	Harris and Hutchinson.
Phillips Petroleum Co	Adams Bldg. Bartlesville, OK 74004	do	Hutchinson and Orange.
Sid Richardson Carbon & Gasoline Co.	1105 Ft. Worth National Bank Bldg. Ft. Worth, TX 76102	do	Howard.
Cement:			
Alpha Portland Cement Co	15 South 3d St. Easton, PA 18042	Quarry and plant	Orange.
Capitol Aggregates, Inc	Rt. 13, Box 412 San Antonio, TX 78209	do	Bexar.
Centex Corp	Box 9294 Corpus Christi, TX 78408	do	Nueces.
General Portland, Inc	2800 Republic Bank Tower Dallas, TX 75201	do	Dallas and Tarrant.
Gifford-Hill & Co., Inc	Box 520 Midlothian, TX 76065	do	Ellis.
Gulf Coast Portland Cement Co., Div. of McDonough Co.	Box 262 Houston, TX 77001	do	Harris.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, CO 80202	do	Do.
Longhorn Cement Div., Kaiser Cement & Gypsum Corp.	Kaiser Ctr. 300 Lakeside Dr. Oakland, CA 94612	do	Bexar.
Lone Star Industries, Inc	Box 47327, Dallas, TX 75247	do	Harris and Nolan.
San Antonio Portland Cement Co.	Box 6925 San Antonio, TX 78209	do	Bexar.
Southwestern Portland Cement Co.	Box 392 El Paso, TX 79943	do	Ector, El Paso, Potter.
Texas Industries, Inc	Box 146 Midlothian, TX 76065	do	Ellis.
Universal Atlas Cement, Div. of United States Steel Corp.	600 Grant St. U.S. Steel Bldg. Pittsburg, PA 15230	do	McLennan.
Clays:			
Acme Brick Co., Div. of Justin Industries, Inc.	Box 425 Ft. Worth, TX 76101	Pit and plant	Denton, Guadalupe, Nacogdoches, Parker, Van Zandt, Wise.
Balcones Minerals Corp	Box B Flatonia, TX 78941	do	Fayette.
Dresser Industries, Inc	601 Jefferson Houston, TX 77002	do	Angelina and Limestone.
Elgin-Butler Brick Co	Box 1947 Austin, TX 78767	do	Bastrop.
Featherlite Corp	Box 141 Ranger, TX 76470	do	Eastland.
General Portland, Inc	Box 2698 Dallas, TX 75201	do	Dallas and Limestone.
General Refractories Co	1520 Locust St. Philadelphia, PA 19102	do	Cherokee.
Gulf Coast Portland Cement Co., Div. of McDonough Co.	Box 262 Houston, TX 77001	Pit	Chambers.
Henderson Clay Products Co	Box 1251 Henderson, TX 75652	Pit and plant	Rusk.
Lone Star Industries, Inc	Box 47327 Dallas, TX 75247	Pit	Fisher and Harris.
Milwhite Co., Inc	Box 15038 Houston, TX 77020	Pit and plant	Fayette and Walker.
Southern Clay Products, Inc	Box 44 Gonzales, TX 78629	do	Angelina, Cherokee, Gonzales.
Texas Clay Products, Inc	Box T Malakoff, TX 75148	do	Henderson.
Texas Industries, Inc	8100 Carpenter Freeway Dallas, TX 75247	do	Comanche, Dallas, Ellis, Fort Bend, Henderson, Marion, Van Zandt.

Table 15.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Coal (lignite):			
ICI United States, Inc	Box 790 Marshall, TX 75670	Strip mine	Harrison.
Industrial Generating Co	Box 1111 Rockdale, TX 76567	do	Milam.
Texas Utilities Generating Co	Box 948 Fairfield, TX 75840	do	Freestone.
Do	Box 1266 Mt. Pleasant TX 75455	do	Titus.
Do	Box 651 Tatum, TX 75691	do	Panola.
Fluorspar: D & F Minerals Co	Box 75 Terlingua, TX 79852	Mine	Brewster.
Graphite: Southwestern Graphite Co.	Burnet, TX 78611	Mine and mill	Burnet.
Gypsum:			
The Celotex Corp	1500 North Dale Mabry Tampa, FL 33607	Quarry and calcining plant.	Fisher.
The Flinkote Co	400 Westchester Ave. White Plains, NY 10604	do	Nolan.
Georgia Pacific Corp	900 Southwest 5th Ave. Portland, OR 97204	do	Hardeman.
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	do	Fisher.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Nolan.
Do	do	Plant	Harris.
Iron ore:			
Lone Star Steel Co	Box 12226 Dallas, TX 75225	Mine	Cass and Morris.
Tex-Iron, Inc	Cushing, TX 75760	do	Nacogdoches.
Lime:			
Aluminum Co. of America	1028 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Calhoun.
Armco Steel Corp	Box 1367 Houston, TX 77001	do	Harris.
Austin White Lime Co	Box 9556 Austin, TX 78766	do	Travis.
Champion International Corp	Box 872 Pasadena, TX 77501	do	Harris.
Chemical Lime Co	Box 427 Clifton, TX 76634	do	Bosque.
Holly Sugar Corp	Drawer 1778 Hereford, TX 79045	do	Deaf Smith.
McDonough Bros., Inc	Fredericksburg Rd. Rt. 8, Box 222 San Antonio, TX 78228	do	Bexar.
PPG Industries, Inc	Box 4026 Corpus Christi, TX 48408	do	Nueces.
Round Rock Lime Co	Box 38 Blum, TX 76627	do	Hill.
Texas Lime Co	Box 851 Cleburne, TX 76031	do	Johnson.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Comal.
Magnesium compounds: The Dow Chemical Co.	2020 Dow Ctr. Midland, MI 48640	do	Brazoria.
Magnesium: American Magnesium Co.	Rt. 1, Box 666 Snyder, TX 79549	do	Scurry.
Perlite:			
Filter Media, Inc	Box 19156 Houston, TX 77024	Expanding plant	Harris.
Perlite of Houston, Inc	Box 8386 Houston, TX 77004	do	Do.
Sil-Flo Corp	Box 7086 Ft. Worth, TX 76111	do	Dallas.
South Texas Perlite Co	Judson Rd. San Antonio, TX 78233	do	Bexar.
Texas Vermiculite Co	2651 Manila Dallas, TX 75212	do	Dallas.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Nolan.
Roofing granules: H. B. Reed & Co., Inc.	8149 Kennedy Ave. Highland, IN 46322	Plant	Milam.
Salt:			
Diamond Shamrock Corp	300 Union Commerce Bldg. Cleveland, OH 44115	Brine wells	Chambers.
The Dow Chemical Co	Midland, MI 48640	do	Brazoria.
Morton Salt Co	110 North Wacker Dr. Chicago, IL 60606	Underground mine and brine wells.	Van Zandt.
PPG Industries, Inc	Box 4026 Corpus Christi, TX 77704	Brine wells	Duval.
Phillips Petroleum Co	Bartlesville, OK 74003	do	Hutchinson.

Table 15.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Salt —Continued			
Texas Brine Corp	2000 West Loop South Houston, TX 77027	Brine wells	Harris, Jefferson, Matagorda.
United Salt Corp	do	Underground mine and brine wells.	Fort Bend and Harris.
Vulcan Materials Co	Box 1060 Denver City, TX 79323	Brine wells	Yoakum.
Sand and gravel:			
Capitol Aggregates, Inc	Rt. 13, Box 142 San Antonio, TX 78209	Stationary plant	Guadalupe and Travis.
Dresser Industries, Inc	Kosse, TX 76653	do	Limestone.
The Fordyce Co	Box 1981 San Antonio, TX 78206	do	Hidalgo, Victoria.
Ft. Worth Sand & Gravel Co	Box 400 Arlington, TX 76010	do	Dallas, Denton, Tarrant.
Gifford-Hill & Co., Inc	Box 47127 Dallas, TX 75247	do	Brazos, Clay, Colorado, Dallas, McLennan, Tarrant, Wichita.
Horton & Horton, Inc	Box 1669 Houston, TX 77001	Portable plant and dredge.	Colorado, Harris, Victoria.
R. E. Janes Gravel Co	Box 2155 Austin, TX 78767	Stationary plant	Borden, Crosby, Lubbock, Taylor.
Lone Star Industries, Inc	Box 47327 Dallas, TX 75247	do	Colorado and Denton.
Parker Bros. & Co., Inc	Box 107 Houston, TX 77001	Stationary plant and dredge.	Colorado and Harris.
Thorstenberg Materials	1435 Bank of the Southwest Houston, TX 77002	do	Do.
Shell:			
Parker Bros. & Co., Inc	5303 Navigation Bldg. Box 107 Houston, TX 77001	Dredge	Calhoun.
Sodium (metallic):			
Ethyl Corp	Box 472 Pasadena, TX 77502	Plant	Harris.
Sodium sulfate (natural):			
Ozark-Mahoning Co	1870 South Boulder Tulsa, OK 74119	do	Gaines and Terry.
Stone:			
Barret Industries	2718 Southwest Military Dr. San Antonio, TX 78221	Quarry	Bexar.
General Portland, Inc	2800 Republic Bank Tower Dallas, TX 75201	do	Dallas, Tarrant, Wise.
Gifford-Hill & Co., Inc	Box 47127 Dallas, TX 75247	do	Wise.
Lone Star Industries, Inc	Box 47327 Dallas, TX 75247	do	Burnet, Nolan.
McDonough Bros., Inc	Rt. 8, Box 222 San Antonio, TX 78228	do	Bexar.
Parker Bros. & Co., Inc	Box 107 Houston, TX 77001	do	Comal.
Texas Crushed Stone Co	Box 9345 Austin, TX 78717	do	Llano and Williamson.
Texas Industries, Inc	Box 146 Midlothian, TX 76065	do	Ellis and Wise.
White's Mines, Inc	Box 499 San Antonio, TX 78206	do	Brown, Taylor, Uvalde.
Sulfur (native):			
Duval Corp	1906 First City National Bank Bldg. Houston, TX 77002	Frasch mine	Culberson.
Farmland Industries, Inc	Box 850 Ft. Stockton, TX 79735	do	Pecos.
Jefferson Lake Sulfur Co	Box 1185 Houston, TX 77001	do	Fort Bend.
Texasgulf, Inc	200 Park Ave. New York, NY 10017	do	Fort Bend, Jefferson, Liberty, Pecos, Wharton.
Sulfur (byproduct):			
Amoco Production	Box 591 Tulsa, OK 74102	Secondary recovery	Andrews, Ector, Hockley, Van Zandt, Wood.
Cities Service Oil Co	Box 300 Tulsa, OK 74102	do	Cochran, Dawson, Gaines, Van Zandt.
Getty Oil Co	Box 8 Scroggins, TX 75480	do	Franklin and Freestone.

Table 15.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sulfur (byproduct)—Continued			
Gulf Oil Corp	Box 701 Port Arthur, TX 77640	Secondary recovery	Jefferson.
Phillips Petroleum Co	Bartlesville, OK 74003	do	Brazoria, Crane, Ector, Hutchinson.
Shell Oil Co	Box 2099 Houston, TX 77001	do	Cass, Harris, Karnes.
Warren Petroleum Corp	Box 1589 Tulsa, OK 74101	do	Crane, Hopkins, Karnes.
Talc:			
Pioneer Talc Co., Inc	Chatsworth, GA 30705	Mine and plant	Hudspeth.
Southern Clay Products, Inc	Box 44 Gonzales, TX 78629	Mine	Do.
United Sierra, Div. of Cyprus Mines Corp.	Box 1201 Trenton, NJ 08606	do	Do.
Westex Talc Co	Box 15038 Houston, TX 77020	Mine and plant	Culberson and Hudspeth.
Uranium:			
Continental Oil Co.-Pioneer Nuclear Corp.	Box 300 Falls City, TX 78113	Open pit mines and mill.	Karnes and Live Oak.
Intercontinental Energy Corp	600 South Cherry Suite 135 Denver, CO 80202	Solution mines and plant.	Bee.
Mobil Oil Corp	Box 5444 Denver, CO 80217	do	Webb.
United States Steel Corp	600 Winnebago St. Corpus Christi, TX 78401	do	Live Oak.
Union Carbide Corp	270 Park Ave. New York, NY 10017	do	Duval.
Wyoming Minerals	55 West 5th Ave. Denver, CO 80204	do	Live Oak and Webb.
Vermiculite:			
W. R. Grace & Co	2651 Manila Rd. Dallas, TX 75200	Exfoliating plant	Bexar and Dallas.
Vermiculite Products, Inc	Box 7327 Houston, TX 77008	do	Harris.
Volite, Inc	Box 122 Llano, TX 78643	Mine and plant	Llano.

The Mineral Industry of Utah

This chapter has been prepared under a Memorandum of Understanding beween the Bureau of Mines, U.S. Department of the Interior, and the Utah Geological and Mineral Survey for collecting information on all minerals.

By William A. McKinney[1]

The value of mineral production in Utah during 1977 surpassed $1 billion for the second time in the mineral history of the State, the first time being in 1976. The total value of nonfuel and fuel minerals produced in Utah in 1977 was $1.1 billion, a 3.2% increase over that of 1976. Increases in value were recorded for metals and nonmetals; mineral fuels declined slightly.

Total value of the metals group increased 7% over that of 1976. Increases in value were noted for all of the metal commodities except lead and zinc. Copper accounted for 61% of the value of the metals group and 24% of the value of all minerals produced in Utah.

The nonmetals group increased 7% in value. Nine commodities increased in value with gypsum, sand and gravel, and cement registering the highest gains. Phosphate rock, pumice, sodium sulfate, gem stones, and magnesium compounds declined in value.

Production of mineral fuels declined slightly in total value, but accounted for about 50% of the total value of mineral production in the State. Petroleum, which, although declining 3% in value, was still the leading mineral commodity in the State in terms of value.

The final Environmetal Impact Statement was released for the Alumet Co.'s proposed alunite-processing plant and mine in Beaver County. The proposed operation would cost $500 million and would employ 1,000 people. Alunite ore would be mined from the Wah Wah Mountains and then processed into alumina at the rate of 500,000 tons per year. Annual production of byproducts would be 370,000 tons of potassium sulfate fertilizer, 1.7 million tons of phosphate fertilizer, and 20,000 tons of aluminum fluoride. The U.S. Environmental Protection Agency (EPA) released a report saying the plant would violate Clean Air Act standards. EPA suggested that the plant emission control system would have to be improved or the plant would have to be located on flatter terrain where pollutants would disperse farther. The entire project has been placed in abeyance awaiting additional financial backing.

Discovery of a deep-lying porphyry-type molybdenum deposit in southwestern Utah was announced by Phelps Dodge Corp. The find resulted from exploratory drilling in the Wah Wah Mountains in Beaver County, a few miles northwest of Alumet's alunite property. Drill holes showed mineralized sections containing as much as 0.38% MoS_2 occurring at depths of 3,000 to 5,000 feet. The early drilling also indicated minor tungsten values.

In mid-1977 Kennecott Copper Corp. began operation of a $280 million sulfur dioxide emission control program at its Garfield copper smelter. By yearend, two of the three Noranda reactors employed in the new smelter for higher sulfur dioxide recovery were brought on-stream. Conversion from conventional reverberatory furnace smelting to the Noranda process is to be completed in 1978.

Legislation and Government Programs.—Continued withdrawal of public lands from prospecting and mining activity is a major source of concern to the mineral industries in Utah. An area of 26,927 acres in the Deep Creek Mountains of Juab and Tooele Counties was withdrawn from mineral exploration by the U.S. Department of the Interior. Prospecting activities by Atlas Minerals, which held some uranium claims in the area, were reported to have led to the emergency withdrawal, the first such action to be made under the provisions of the Federal Land Policy and Management Act of 1976. The Bureau of Land Management (BLM) stated that the withdrawal, which affects only a small portion of the 154,000 acres of the BLM Deep Creek Management Unit, was made to protect a number of rare fish, plant, and animal species, plus a number of Indian archeological sites, some dating back 9,000 years. The withdrawal order will be in effect until 1980, at which time the BLM will make specific recommendations to Congress for permanent designation of the area.

The 29,567-acre Lone Peak area southeast of Salt Lake City in the Wasatch Mountain Range was officially designated as a Wilderness Area, the first region in Utah to be so designated. Eleven other Utah sites are under study by the BLM as "instant study areas" for review for possible wilderness status.

The Bureau of Mines awarded a metallurgy research grant in the amount of $22,700 to the University of Utah to obtain fundamental information on the leaching behavior of the copper sulfide mineral bornite, and to incorporate this information in mathematical modeling of copper waste dump leaching. Previous Bureau grants to the University of Utah on modeling of oxide copper ore leaching, kinetics of gold and silver adsorption on activated carbon, solvent extraction of copper from ammonia solutions, evaluation of native plants for tailings stabilization and modeling of lead sintering were still in effect during 1977.

The Utah Geological and Mineral Survey completed two grants awarded by the Federal Bureau of Mines to develop data for the Mineral Availability System on lead and zinc deposits and iron ore occurrences in Utah. Detailed mine mapping of gassy seams was started on a Bureau of Mines grant for collection of data on the methane content of Utah coals.

Table 1.—Mineral production in Utah[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide, natural thousand cubic feet	21,875	$2	W	W
Clays thousand short tons	[2]206	[2]531	[3]244	[3]$713
Coal (bituminous) do	7,967	182,712	8,581	174,342
Copper (recoverable content of ores, etc.) short tons	185,458	258,157	194,130	259,357
Fluorspar do	W	W	--	--
Gem stones	NA	105	NA	100
Gold (recoverable content of ores, etc.) troy ounces	187,318	23,475	210,501	31,219
Gypsum thousand short tons	270	1,657	324	2,510
Iron ore (usable) thousand long tons, gross weight	W	W	1,932	19,780
Lead (recoverable content of ores, etc.) short tons	16,297	7,529	10,746	6,598
Lime thousand short tons	202	6,855	209	8,274
Natural gas million cubic feet	57,416	28,995	60,696	37,146
Petroleum (crude) thousand 42-gallon barrels	34,304	318,911	33,113	308,872
Pumice thousand short tons	164	264	W	W
Salt do	705	10,090	843	10,831
Sand and gravel[4] do	10,547	13,442	11,895	18,662
Silver (recoverable content of ores, etc.) thousand troy ounces	3,134	13,633	3,283	15,169
Stone thousand short tons	2,751	7,009	2,771	7,310
Tungsten thousand pounds contained W	W	W	27	219
Zinc (recoverable content of ores, etc.) short tons	22,481	16,636	17,759	12,218

See footnotes at end of table.

Table 1.—Mineral production in Utah[1] —Continued

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Combined value of asphalt, beryllium concentrate, cement (masonry and portland), clays (kaolin and fuller's earth), magnesium compounds, molybdenum, natural gas liquids, phosphate rock, potassium salts, sand and gravel (industrial), sodium sulfate, uranium, vanadium, and values indicated by symbol W	XX	[r]162,102	XX	172,019
Total	XX	[r]1,052,105	XX	1,085,339
Total 1967 constant dollars	XX	378,232	XX	[p]535,723

[p] Preliminary. [r] Revised. NA Not available. W Withheld to avoid disclosing company proprietary data, included in "Combined value" figure.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes kaolin; included in "Combined value" figure.

[3] Excludes kaolin and fuller's earth; included in "Combined value" figure.

[4] Excludes industrial sand and gravel; included in "Combined value" figure.

Table 2.—Value of mineral production in Utah, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Beaver	W	$30	Sand and gravel.
Box Elder	$2,468	1,923	Stone, sand and gravel, lime, salt, tungsten.
Cache	W	1,114	Sand and gravel, stone.
Carbon	90,249	W	Carbon dioxide, sand and gravel.
Daggett	920	--	
Davis	2,083	W	Sand and gravel, stone, tungsten.
Duchesne	176,357	W	Sand and gravel, stone.
Emery	82,532	W	Uranium, sand and gravel, vanadium.
Garfield	W	W	Uranium, vanadium, sand and gravel.
Grand	11,852	6,792	Potassium salts, uranium, vanadium, salt, sand and gravel.
Iron	11,374	W	Iron ore, sand and gravel.
Juab	930	W	Silver, gold, copper, gypsum, clays.
Kane	149	396	Sand and gravel.
Millard	W	W	Pumice, gypsum, tungsten, sand and gravel, beryllium.
Morgan	W	W	Cement, stone, sand and gravel.
Piute	W	W	Clays, zinc, lead, silver, gold.
Rich	W	W	Phosphate rock.
Salt Lake	325,266	344,518	Copper, gold, molybdenum, cement, silver, sand and gravel, salt, lime, stone, clays.
San Juan	154,072	W	Uranium, vanadium.
Sanpete	1,856	2,311	Sand and gravel, gypsum, salt, clays.
Sevier	13,437	2,308	Gypsum, sand and gravel, salt, clays.
Summit	29,987	12,834	Zinc, lead, silver, clays, stone, copper.
Tooele	15,154	17,362	Lime, salt, potassium salts, stone, sand and gravel, magnesium compounds, tungsten, clays.
Uintah	63,275	17,049	Phosphate rock, asphalt, stone, sand and gravel.
Utah	W	18,755	Zinc, silver, gold, lead, sand and gravel, copper, clays, tungsten.
Wasatch	181	258	Sand and gravel, stone.
Washington	W	W	Stone, sand and gravel.
Wayne	W	40	Sand and gravel.
Weber	13,183	18,232	Potassium salts, salt, asphalt, sodium sulfate, sand and gravel, magnesium compounds, stone, clays.
Undistributed[1]	[r]56,744	641,414	
Total[2]	[r]1,052,105	1,085,339	

[r] Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes some sand and gravel that cannot be assigned to specific counties, gem stones, natural gas (1977), natural gas liquids (1977), petroleum (1977), coal (1977), and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Utah business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	513.0	528.0	+2.9
Unemployment do	29.0	28.0	-3.4
Employment (nonagricultural):			
Mining do	14.0	14.7	+5.0
Manufacturing do	70.7	74.4	+5.2
Contract construction do	27.9	30.6	+9.7
Transportation and public utilities do	28.1	29.2	+3.9
Wholesale and retail trade do	112.0	118.1	+5.4
Finance, insurance, real estate do	20.6	22.0	+6.8
Services do	77.4	80.9	+4.5
Government do	112.2	114.1	+1.7
Total nonagricultural employment do	462.9	484.0	+4.6
Personal income:			
Total millions	$6,680	$7,510	+12.4
Per capita	$5,422	$5,923	+9.2
Construction activity:			
Number of private and public residential units authorized	18,141	22,191	+22.3
Value of nonresidential construction millions	$154.0	$173.1	+12.4
Value of State road contract awards do	$62.5	$55.0	-12.0
Shipments of portland and masonry cement to and within the State thousand short tons	922	902	-2.2
Mineral production value:			
Total crude mineral value millions	$1,052.1	$1,085.3	+3.2
Value per capita, resident population	$857	$856	-.1
Value per square mile	$12,390	$12,781	+3.2

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

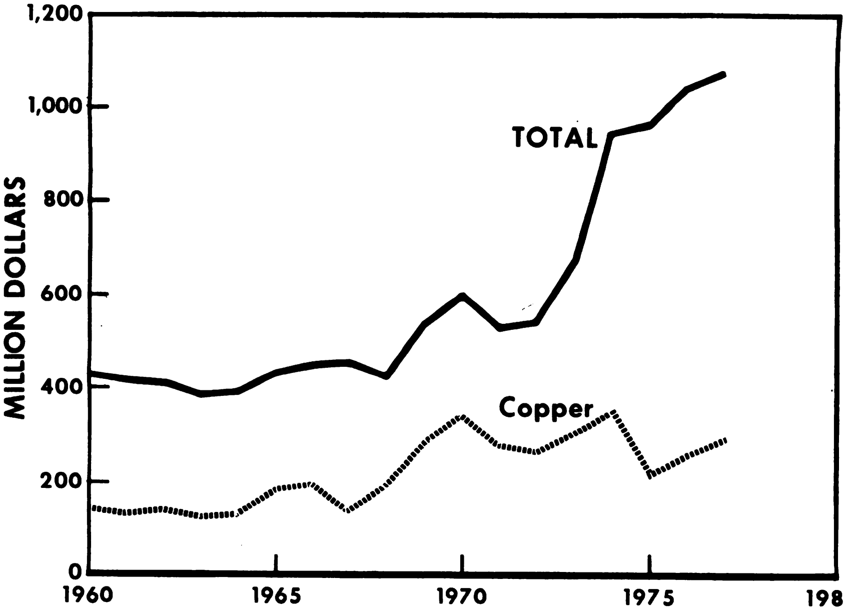

Figure 1.—Value of mine production of copper, and total value of mineral production in Utah.

REVIEW BY MINERAL COMMODITIES

METALS

Beryllium.—Brush Wellman, Inc., continued mining operations at Spor Mountain and processing operations at its plant near Delta. Beryllium production was approximately the same as in 1976.

Copper.—At the first of the year, Kennecott Copper Corp.'s Utah Copper Division went back to a 7-day work schedule for the first time in nearly 2 years. However, later in the year, in the face of sharply declining copper prices and a highly competitive world market, the Utah Copper Division announced a 10% reduction of its 7,000-employee work force. The first cut was made August 31, when 100 administrative staff and supervisory employees and 80 union employees were laid off. The remaining reduction was to take place over a 12-month period through retirements, interdepartmental transfers, and attrition without replacements. Development of The Anaconda Company's Carr Fork copper project proceeded on schedule, with production slated to begin in 1979. Output of copper increased nearly 5% over that of the previous year, but the total value was up less than 1%. Kennecott's Bingham Canyon mine was the largest single copper producer in the United States. Other significant copper producers in the State included the Trixie mine of Kennecott Copper Corp. in Utah County, the Ontario mine of Park City Ventures in Summit County, and the Mammoth mine of Kennecott Copper Corp. in Juab County. Copper production was recorded from five mines in four counties.

Table 4.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing[1] (lode)	Material sold or treated (short tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
1975, total	6	27,751,500	189,620	$30,621,734	2,821,730	$12,472,048
1976, total	8	30,053,234	187,318	23,474,692	3,134,021	13,632,991
1977:						
Juab	1	22,799	3,351	496,987	195,351	902,522
Salt Lake	1	32,614,227	W	W	W	W
Utah	2	285,313	W	W	791,865	3,658,416
Undistributed[2]	2	131,935	207,150	30,722,416	2,296,107	10,608,015
Total	6	33,054,274	210,501	31,219,403	3,283,323	15,168,953

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1975, total	177,155	$227,467,442	12,679	$5,452,099	19,640	$15,319,143	$291,332,466
1976, total	185,458	258,157,279	16,297	7,529,112	22,481	16,636,194	319,430,268
1977:							
Juab	54	71,517	--	--	--	--	1,471,026
Salt Lake	193,698	258,781,059	--	--	--	--	W
Utah	312	416,214	4,237	2,601,480	8,679	5,970,844	12,646,954
Undistributed[2]	66	88,591	6,510	3,996,834	9,080	6,247,312	310,444,227
Total[3]	194,130	259,357,381	10,746	6,598,314	17,759	12,218,156	324,562,207

W Withheld to avoid disclosing company proprietary data; included in "Undistributed."

[1] Operations at old mill or miscellaneous cleanups not counted as producing mines, nor are various uranium mines counted from which byproducts were recovered.

[2] Includes Piute and Summit Counties combined to avoid disclosing company proprietary data, and items indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 5.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold-silver and silver[2]	2	100,409	[3]209,454	[3]2,664,874	344	– –	– –
Copper	1	32,582,780	W	W	169,010	– –	– –
Lead-zinc	3	339,638	1,047	618,449	88	10,746	17,759
Total	6	32,922,418	1,047	618,449	169,098	10,746	17,759
Other lode material:							
Copper precipitates	1	31,447	– –	– –	24,689	– –	– –
Grand total[4]	6	33,054,274	210,501	3,283,323	194,130	10,746	17,759

W Withheld to avoid disclosing company proprietary data; included in "Gold-silver and silver ores."

[1] Detail will not add to total because some mines produce more than one class of material.

[2] Combined to avoid disclosing company proprietary data.

[3] Includes gold and silver from copper ore.

[4] Data may not add to totals shown because of independent rounding.

Table 6.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1977, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Smelting of concentrates	183,405	2,501,293	169,039	10,746	17,759
Direct smelting of:					
Ore	27,096	782,030	402	– –	– –
Copper precipitates	– –	– –	24,689	– –	– –
Total	210,501	3,283,323	194,130	10,746	17,759

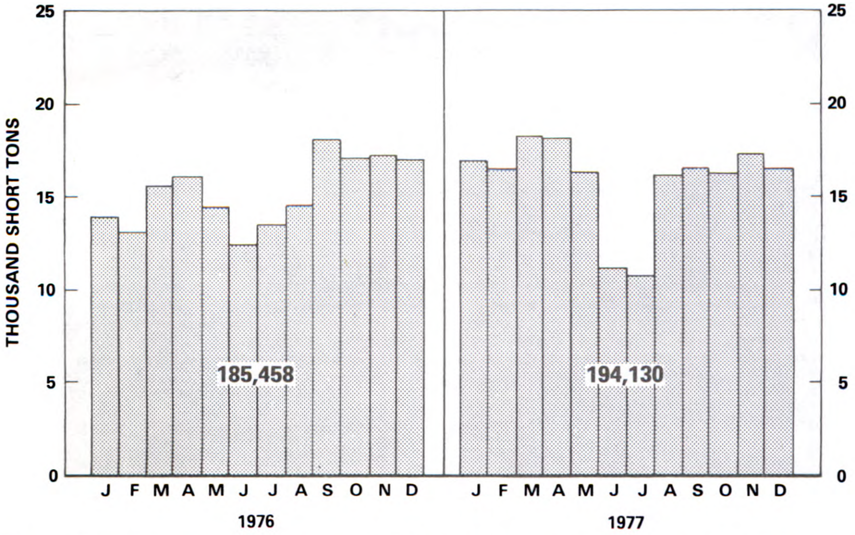

Figure 2.—Mine production of copper in Utah, by months in terms of recoverable metals.

Gold.—Production of gold increased by 12% over that of 1976, and the value of gold production increased 33%, reflecting continued increases in the price of gold. Gold was produced from six mines in four counties. The principal producer of gold in the State remained the Kennecott Copper Corp. at the Utah Copper mine in Bingham Canyon. Kennecott's Trixie mine in Utah County in the East Tintic mining district was second in gold production. The famous Mammoth mine of Kennecott Copper Corp. in Juab County, idle for over 20 years, is now producing again.

Iron Ore.—As in previous years, all of the iron ore produced in the State came from Iron County. Three companies were active. CF&I Steel Corp. operated the Comstock mine, United States Steel Corp. produced ore from the Mountain Lion mine, and Utah International, Inc., produced lower grade ores from the Thompson and Iron Springs mines for concentration at its magnetic separation plant at Iron Springs. The average iron content of the direct shipping ores and concentrates was 54.06%, slightly lower than the corresponding figure for 1976. Both the tonnage shipped and the value were up over those of 1976.

Lead.—The major lead producers were the Ontario mine of Park City Ventures and the Burgin mine of Kennecott Copper Corp. Production of lead dropped sharply from that of the previous year with 1977 production being down 34% from that of 1976. Due to increased lead prices in 1977, value of lead production only decreased by about 12%.

Magnesium.—The magnesium plant of NL Industries, Inc., on the west shore of Great Salt Lake, resumed production after completion of a $55 million modification program in which three-fourths of the production cells were revamped. The rated capacity of the plant is now 25,000 tons of magnesium per year, as opposed to the original design capacity of 40,000 tons per year. No figures are available for the actual production, however.

Molybdenum.—All of the molybdenum produced in the State was a byproduct of copper production at the Utah Copper Division of Kennecott Copper Corp. Although copper production increased somewhat, the production of molybdenum decreased about 8%. Due to increased prices for the commodity, however, the value of molybdenum production increased nearly 14% over that of 1976.

Selenium.—Production of selenium was up 116% over that of 1976. As in past years, the total Utah production resulted from the refining of copper ores from the Kennecott Copper Corp. mine at Bingham Canyon.

Silver.—Production of silver increased nearly 5% over that of 1976, and the value of silver produced increased over 11%. The leading silver producer continued to be the Utah Copper mine of Kennecott Copper Corp. Kennecott's other Utah mines, the Mammoth in Juab County and the Burgin and Trixie mines in Utah County, were also significant producers. The other major producer of silver was the Ontario mine of Park City Ventures in Summit County. Silver was produced by a total of six mines in five counties.

Tungsten.—Rising prices for tungsten stimulated production in Utah. Major production came from the Gold Hill area of Tooele County (two mines), Millard County (four mines), and Box Elder County (two mines). During the year, a total of 10 mines in 5 counties produced tungsten ores. High grade crude ore or concentrate found ready markets at Bishop, Calif., or Fallon, Nev.

Uranium.—Production of uranium increased for the fourth straight year. High uranium prices stimulated both exploration and production. Energy Fuels, Inc., opened ore-buying stations at Blanding in San Juan County and Hanksville, in Wayne County. The company announced plans to stockpile the ore until production in the districts reached a level sufficient to justify construction of a processing mill. The proposed mill would be constructed near Blanding early in 1980 at a cost of $28 to $35 million and would be designed to process 1,500 tons of ore per day. Atlas Corp. announced a $750,000 expansion of its alkaline leach circuit, and increased employment at its mill at Moab from 125 to 160 during the year. Plateau Resources, Ltd., also started buying and stockpiling ore for a proposed 750-ton-per-day mill in the Blanding area. The quantity and value of uranium produced in 1977 were up 5% and 29%, respectively.

Vanadium.—Production of vanadium was up about 4% over that of 1976, but the value of production increased by 8%. Nearly all of the vanadium-bearing ore came from San Juan County, although three other counties also produced some vanadium. Utah ranked third out of the five States that produced vanadium in 1977.

Zinc.—Zinc was produced at three mines in three counties in 1977, with the Ontario mine of Park City Ventures in Summit County and the Burgin mine of Kennecott Copper Corp. in Utah County being the major producers. Production decreased by 21% from that of 1976 and value decreased nearly 27%.

MINERAL FUELS

Several expansion programs were underway at Utah's coal mines during 1977, and several new mines started in 1976 came into full production. Several companies announced acquisition of coal leases and plans for immediate development. Recoverable reserves of coal in Utah are estimated at 23.4 billion tons. However, about 41% of the identified reserves are located in the Kaiparowits Plateau and Kolob coalfields in the southern part of the State, where environmental concerns and the high cost of recovery have prevented development.

Oil and gas drilling in 1977 accounted for 14 new field discoveries. Six of the new discoveries were oil wells, and eight were gas producers; one was considered to be the most significant gas discovery made in a decade. Proven reserves of crude oil in Utah are estimated at 274 million barrels. Most of this is located in four large fields, the Greater Altamont-Bluebell and Greater Red Wash fields in the Uintah Basin, the Pineview field in Summit County, and the Greater Aneth field in the southeastern corner of Utah.

NONMETALS

Barite.—No crude barite was mined in Utah, but five companies in Salt Lake County crushed and ground barite for oil well drilling mud. The companies were All Minerals Corp., Custom Milling and Supply, Eisenmann Chemical Co., Rocky Mountain Refractories, and Westemco, Inc. Production of ground barite in 1977 was more than 15% higher than during the previous year.

Cement.—Output of portland cement increased 13% over that of the previous year and value increased 33%. Production of masonry cement declined somewhat with production and value down 10% and 2%, respectively. Two companies accounted for all of the production—Ideal Cement Co., Division of Ideal Basic Industries, Inc., and Portland Cement Co. of Utah. Ready-mix concrete companies purchased about 78% of the portland cement sold, manufacturers of concrete products took 9%, building material dealers bought over 5%, highway contractors took nearly 4%, and the remainder went to other contractors, government agencies, and miscellaneous customers. Raw materials consumed in the manufacture of portland cement were mainly limestone and cement rock with smaller quantities of gypsum, slag, and sandstone.

Clays.—Production of clays increased about 19%, and value was up about 34%. The major producers were Utelite Corp., Mountain Fuel Supply Co., and Interpace Corp. Mining was conducted at 14 mines in 9 counties. Most of the clays were used in the manufacture of brick and concrete block or in structural concrete. Smaller quantities were used in drilling muds, oil refinery catalysts, or waterproofing compositions.

Gypsum.—Five companies, Thomas J. Peck & Sons, Inc., of Juab County, White Mountain Gypsum Co. of Millard County, Cox Enterprises, Inc. of Sanpete County, and United States Gypsum Co. and Georgia-Pacific Co. of Sevier County, produced crude gypsum in 1977. Production was up 20% and value was up more than 51% over that of 1976. U.S. Gypsum and Georgia-Pacific continued to produce calcined gypsum.

Lime.—Lime was produced by four companies during the year, Utah-Idaho Sugar Co., Kennecott Copper Corp., the U.S. Lime Division of The Flintkote Co., and Utah Marblehead Lime Co. Production increased about 3% from that of 1976, but the value of the lime produced increased by nearly 21%.

Magnesium Compounds.—Magnesium compounds were produced by the Great Salt Lake Minerals & Chemicals Corp. in Weber County and Kaiser Aluminum & Chemical Corp., in Tooele County. Both production and value decreased slightly from that of 1976. Magnesium chloride was also produced by NL Industries, Inc., as a feed for its magnesium metal production plant on the west shore of Great Salt Lake, but no figures are available for this production.

Perlite.—Plants of the Pax Co. in Salt Lake County and Georgia-Pacific Corp. in Sevier County produced expanded perlite from out-of-state sources. The Lehi Block Co. and Perlite Products closed its plant in Utah County.

Phosphate Rock.—Stauffer Chemical Co. continued to be the only producer of phosphate rock in Utah. Stauffer operated two mines during the year—the Crawford Mountains mine, a small underground mine in Rich County, and the Vernal mine, a large open pit operation in Uintah County. Production and value declined about 11% and 21%, respectively.

Potash.—Three companies produced potassium salts during the year. Texasgulf, Inc., used solution mining to extract potash from beds near Moab in Grand County, Kaiser Aluminum & Chemical Corp. extracted salts from the salt flats near Wendover in Tooele County, and Great Salt Lake Minerals & Chemicals Corp. produced salts from the evaporation of Great Salt Lake waters west of Ogden in Weber County. Production declined nearly 11% from that of the previous year; value also declined. Several potential new production operations were in the exploratory stage during the year. Butte Resources Co. was studying the economic possibilities of solution mining on a 50,000-acre tract about 15 miles northwest of Moab, and Texasgulf, Inc., drilled an exploratory well at a site 20 miles northeast of its present plant and outlined several other potential ore bodies for possible future testing.

Pumice.—Only one company, Fillmore Products, Inc., Millard County, produced pumice in 1977. Most of the production was used for landscaping and the remainder for concrete aggregate. The Utah State Road Commission mine near Cedar City in Iron County was inactive during the year.

Salt.—Eight companies in seven counties produced salt in 1977. Evaporated salt was produced by five companies operating in Box Elder, Salt Lake, Tooele, and Weber Counties. One mine each in Sanpete and Sevier Counties produced rock salt and a mine in Grand County produced brine. Salt production increased by nearly 20%, but the value of production increased by only 7%.

Sand and Gravel.—Production of construction sand and gravel increased 13% in 1977, and an increase in the average unit price from $1.27 per ton in 1976 to $1.57 per ton in 1977 resulted in an increase in value of about 39%.

Sand and gravel continued to occupy third place in the total value of production in the nonmetallic mineral category, being surpassed only by cement and potassium salts. The number of companies involved in sand and gravel production decreased from 77 in the previous year to 70 in 1977, and the number of deposits being mined decreased from 85 to 80. A total of 67 plants were operated in 23 counties during the year. Salt Lake County continued to be the major producer in the State, followed by Davis and Utah Counties. Operations in these three counties accounted for 67% of the sand and gravel production of Utah.

Sodium Sulfate.—Great Salt Lake Minerals & Chemicals Corp. was the only producer of sodium sulfate during the year. Production and value both decreased about 5% from the 1976 figures.

Stone.—Five companies quarried dimension stone for rough blocks, rough flagging, sawed building stone, rubble, rough construction stone, and house stone veneer. Output decreased 9% to 6,070 tons valued at $238,000. Leading companies were Star Stone, Inc., W. H. Hansen Stone Quarry, Inc., and Cleo & Raggie Teeter. Ten companies crushed stone at 23 quarries for cement, fluxstone, riprap, and other uses. Output increased 1% to 2.77 million tons valued at $7.07 million. Leading producers were United States Steel Corp., Ideal Basic Industries, and Portland Cement Co. of Utah.

Vermiculite.—No crude vermiculite was produced in 1977, but one company, Vermiculite Intermountain, Inc., produced exfoliated vermiculite from out-of-state sources. More than one-half of the production was used as loose fill insulation, while the remainder went into concrete and plaster aggregate.

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[1] State Liaison Officer, Bureau of Mines, Salt Lake City, Utah.

Table 7.—Utah: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Cement manufacture	928	2,476	1,037	2,870
Dense graded road base stone	26	51	70	150
Concrete aggregate	--	--	42	96
Roadstone	10	21	37	63
Fill	--	--	4	9
Bedding material	--	--	(2)	1
Other uses[3]	1,780	4,133	1,575	3,883
Total	2,744	6,681	2,765	7,072

[1] Includes limestone, miscellaneous stone, granite (1977), sandstone, and marble (1977).

[2] Less than 1/2 unit.

[3] Includes stone used in flux stone, ferrosilicon (1976), riprap and jetty stone, lime manufacture (including dead-burned dolomite), surface treatment aggregate, mine dusting, refractory stone (1976), agricultural limestone, railroad ballast, terrazzo and exposed aggregate, stone sand (1976), mineral food (1976), and other unspecified uses.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt:			
American Gilsonite Co	Suite 1150, Kennecott Bldg. Salt Lake City, UT 84110	Underground mine and plant.	Uintah.
Beryllium:			
Brush Wellman, Inc	67 West 2950 South Salt Lake City, UT 84115	Open pit mines and plant.	Juab and Millard.
Carbon dioxide, natural:			
Equity Oil Co	806 American Oil Bldg. Salt Lake City, UT 84101	Well and plant	Carbon.
Cement:			
Ideal Basic Industries, Inc.[1]	Cement Division Star Route Morgan, UT 84050	Open pit mine and plant.	Morgan.
Portland Cement Co. of Utah[1]	615 West 800 South Box 1469 Salt Lake City, UT 84110	do	Salt Lake and Tooele.
Clays:			
Filtrol Corp	2580 Andrew Ave. Salt Lake City, UT 84115	Open pit and underground mines and plant.	Juab and Salt Lake.
Interpace Corp	736 West Harrisville Rd. Ogden, UT 84402	Open pit mine	Box Elder, Salt Lake, Sevier, Utah, Weber.
Utelite Corp	Box 387 Coalville, UT 84017	Open pit mine and plant.	Summit.
Coal:			
American Coal Co	190 North Main Huntington, UT 84528	Underground mine	Emery.
Kaiser Steel Corp	Sunnyside Coal Mines Sunnyside, UT 84539	Underground mines and plant.	Carbon.
Peabody Coal Co	301 N. Memorial Dr. St. Louis, MO 36102	Underground mine	Emery.
Copper:			
Kennecott Copper Corp.[2]	Box 11299 Salt Lake City, UT 84111	Open pit mine, mills, smelter, refinery.	Salt Lake and Utah.
Gypsum:			
Georgia Pacific Corp	Sigurd, UT 84657	Open pit mine and plant.	Sevier.
United States Gypsum Co	Box 128 Sigurd, UT 84657	do	Do.
Iron ore:			
CF&I Steel Corp	Box 100 Cedar City, UT 84720	Open pit mines	Iron.
United States Steel Corp	Box 859 Cedar City, UT 84720	do	Do.
Utah International, Inc	Box 649 Cedar City, UT 84720	Open pit mines and plants.	Do.
Lead:			
United Park City Mines Co.[3]	Box 1450 Park City, UT 84060	Underground mine and plant.	Summit.
Lime:			
The Flintkote Co.[1]	Box 357 Grantsville, UT 84029	Open pit mine and plant.	Tooele.
Utah-Marblehead Lime Co	Box 268 Tooele, UT 84074	do	Do.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Magnesium:			
NL Industries, Inc	238 North 2200 West Salt Lake City, UT 84116	Plant	Do.
Petroleum and natural gas:[4]			
Phosphate rock:			
Stauffer Chemical Co	Manila Star Route Vernal, UT 84078	Underground mine and plant.	Rich, Salt Lake, Uintah.
Potassium salts:			
Great Salt Lake Minerals & Chemicals Corp.[5]	765 North 10500 West Box 1190 Ogden, UT 84402	Plant	Weber.
Kaiser Aluminum & Chemical Corp.[6]	Box 580 Wendover, UT 84083	do	Tooele.
Texasgulf, Inc	Box 1208 Moab, UT 84532	Underground mine and refinery.	Grand.
Salt:			
American Salt Co	Box 477 Grantsville, UT 84029	Plant	Tooele.
Morton Salt Co	A.M.F. Box 22054 Salt Lake City, UT 84122	do	Salt Lake.
Sand and gravel:			
Cox Enterprises, Inc	50 East First North Manti, UT 84642	Pits	Sanpete.
Gibbons & Reed Co	825 West 1000 North Box 30429 Salt Lake City, UT 84116	Pits and plants	Davis, Salt Lake, Weber.
Monroc Sand and Gravel	1730 Beck St. Box 537 Salt Lake City, UT 84116	do	Salt Lake.
Parson Ready-Mix Co., Inc	33 South 900 East Box 517 Brigham City, UT 84302	do	Box Elder, Cache, Davis.
Stone:			
Southern Pacific Transportation Co.	401 I St. Sacramento, CA 95814	Quarry	Box Elder.
Thomas American Stone Co	989 Jewel Ave. Salt Lake City, UT 84104	Quarries	Box Elder, Tooele, Wasatch.
United States Steel Corp., Western Stone Operations	Box 510 Provo, UT 84601	Quarry	Utah.
Uranium:			
Atlas Minerals Division of Atlas Corp.[7]	Box 1207 Moab, UT 84532	Underground mines and plant.	Emery, Grand, San Juan.
Plateau Resources, Ltd	722 Horizon Dr. Grand Junction, CO 81501	Underground mines	Garfield.
Rio Algom Corp.[7]	Box 610 Moab, UT 84532	Underground mine and plant.	San Juan.
Union Carbide Corp	Box 1029 Grand Junction, CO 81501	Underground mines	Grand and San Juan.

[1] Also stone.
[2] Also gold, silver, lead, zinc, molybdenum, selenium, lime, and stone.
[3] Also zinc, copper, gold, and silver.
[4] Many of the major oil companies and some of the smaller companies operate in Utah; the companies are listed in several commercial directories.
[5] Also salt and magnesium compounds.
[6] Also magnesium compounds.
[7] Also vanadium.

The Mineral Industry of Vermont

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Office of the State Geologist, Agency of Environmental Conservation, for collecting information on all minerals except fuels.

By William R. Barton[1] and Charles A. Ratté[2]

The value of minerals produced in Vermont during 1977 was 18% higher than in 1976, according to tabulations by the Federal Bureau of Mines. The higher value reflected increased production of almost all mineral commodities. The major commodities produced in the State in decreasing order of value were: Stone, asbestos, sand and gravel, and talc. The upward trend in product values reflected continued investment in the expansion and modernization of Vermont mining and mineral-processing facilities.

Vermont is a major producer, and an important exporter to other States, of certain nonmetallic mineral products. The State more than fulfills its per capita share of supplying nonmetallic minerals for the national economy, producing about 8 1/2 tons per capita compared with a national average requirement of about 6 tons of nonmetallics per citizen. Vermont leads the Nation in talc production, ranks second in asbestos, dimension marble, dimension slate, and dimension granite. It is also an important and growing source of ground calcium carbonate for industrial fillers and extenders. Some of the Vermont dimension stones such as Barre gray granite, Danby Imperial white marble, Isle LaMotte black marble, and green verde antique are of international repute and importance. Six of the Nation's leading dimension stone quarries are in Vermont, and 2 of these are among the top 10 for size when measured by value of product. One of the two largest chrysotile asbestos mines in the Nation is in Vermont.

Table 1.—Mineral production in Vermont[1]

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Sand and gravel[2] thousand short tons	2,379	$3,758	3,405	$5,837
Stone do	1,978	22,443	2,244	27,296
Talc do	253	1,685	310	2,006
Combined value of asbestos, gem stones, and sand and gravel (industrial)	XX	7,211	XX	6,415
Total	XX	35,097	XX	41,454
Total 1967 constant dollars	XX	18,015	XX	[p]20,462

[p]Preliminary. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes industrial sand and gravel.

Table 2.—Value of mineral production in Vermont, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Addison	$3,167	W	Stone, sand and gravel.
Bennington	310	$593	Sand and gravel, stone.
Caledonia	1,822	W	Stone, sand and gravel.
Chittenden	1,646	W	Sand and gravel, stone.
Essex	W	W	Sand and gravel.
Franklin	W	W	Stone, sand and gravel.
Grand Isle	W	W	Stone.
Lamoille	W	W	Talc, sand and gravel, stone.
Orange	W	990	Stone, sand and gravel.
Orleans	W	W	Asbestos, sand and gravel, stone.
Rutland	8,983	W	Stone, sand and gravel.
Washington	7,110	W	Do.
Windham	W	W	Talc, sand and gravel, stone.
Windsor	W	W	Do.
Undistributed[1]	12,061	39,869	
Total[2]	35,097	41,454	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes gem stones and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Vermont business activity

		1976	1977p	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	216.0	227.0	+5.1
Unemployment	do	19.0	16.0	-15.8
Employment (nonagricultural):				
Mining	do	.7	.7	--
Manufacturing	do	41.0	43.3	+5.6
Contract construction	do	7.8	8.1	+3.8
Transportation and public utilities	do	8.2	8.3	+1.2
Wholesale and retail trade	do	35.0	36.5	+4.3
Finance, insurance, real estate	do	6.8	7.0	+2.9
Services	do	38.2	40.1	+5.0
Government	do	30.9	31.6	+2.3
Total nonagricultural employment	do	168.6	175.6	+4.2
Personal income:				
Total	millions	$2,584	$2,814	+8.9
Per capita		$5,414	$5,823	+7.6
Construction activity:				
Number of private and public residential units authorized		2,201	2,947	+33.9
Value of nonresidential construction	millions	$14.4	$11.9	-17.4
Value of State road contract awards	do	$31.4	$30.0	-4.5
Shipments of portland and masonry cement to and within the State	thousand short tons	114	137	+20.2
Mineral production value:				
Total crude mineral value	millions	$35.1	$41.5	+18.1
Value per capita, resident population		$74	$85	+14.9
Value per square mile		$3,653	$4,314	+18.1

pPreliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the Vermont mineral industry in 1977[1]

	Employees	Employee hours	Fatal injuries	Fatal injury frequency rate	Nonfatal disabling injuries	Nonfatal disabling injury frequency rate	Nondisabling injuries	Nondisabling injury frequency rate
Sand and gravel:								
Surface	192	192,089	--	--	3	15.62	3	15.62
Office	42	47,714	--	--	--	--	--	--
Total	234	239,803	--	--	3	12.51	3	12.51
Stone:								
Underground	36	65,430	--	--	4	61.13	1	15.28
Surface	401	699,713	--	--	21	31.36	18	26.88
Mill	269	467,026	--	--	8	17.13	7	14.99
Office	72	127,048	--	--	--	--	--	--
Total	778	1,359,217	--	--	33	24.83	26	19.56
Talc:								
Underground	59	130,411	--	--	15	115.02	2	15.34
Surface	3	4,408	--	--	1	226.86	--	--
Mill	87	198,011	--	--	14	70.70	13	65.65
Office	26	46,579	--	--	--	--	--	--
Total	175	379,409	--	--	30	79.07	15	39.54
State total:								
Underground	95	195,841	--	--	19	97.02	3	15.32
Surface	649	1,007,912	--	--	29	28.77	21	20.84
Mill	478	901,059	--	--	26	28.85	20	22.20
Office	161	261,621	--	--	--	--	--	--
Total	1,383	2,366,433	--	--	74	31.27	44	18.59

[1] Data supplied by Mine Safety and Health Administration, U.S. Department of Labor.

The Vermont mineral industry is of critical importance to Vermont railroads. The Vermont Northern Railroad normally derives about one-half of its revenue from mineral products; 20% of the total traffic over the Vermont Railway is in Vermont minerals; the Green Mount Railroad relies upon minerals for about 75% of its traffic; and the Montpelier and Barre Railroads depend upon shipments of granite for profitable operation. In addition, truck transport of Vermont mineral products is estimated to provide employment for about 150 persons.

The mining and quarrying sector paid 3% of Vermont corporate income taxes in 1977. Additional corporate taxes were paid by firms processing and finishing mineral products. These percentages represent a share of total industrial taxes paid, not just manufacturing.

In some areas, the mineral industry pays a significant share of property taxes. The Barre granite industry is a prominent example, paying 17% of all Barre Township property taxes and more than 7% of the property taxes collected by the City of Barre.

Because Vermont has no indigenous mine production of metal or mineral fuels, all such material must be imported for consumption. In addition, many key chemical and industrial nonmetallic raw materials are not produced in Vermont. For example, in 1977 the State imported about 137,000 tons of cement. Other mineral products consumed in substantial quantities but not produced in Vermont include (but are not limited to) abrasives, aluminum, clay bricks, copper, gypsum products, iron and steel, lime, mineral fertilizers, and salt. Vermont is almost totally dependent upon mineral-derived imported fuels for energy. Only 7% of energy requirements are met from hydropower. The rest is derived 58% from petroleum products, 32% from nuclear sources, 2% from natural gas, and 1% from coal.

Vermont produces about $85 worth of minerals annually per capita, compared with a national average of $356; the value of mineral output per square mile is $4,300, compared with a national average of $21,324.

About 40,000 pounds of new mineral materials are required annually, including mineral fuels, to support each U.S. citizen. In Vermont about 13,000 pounds per capita are produced. The deficiency is mostly due to nonexistent production of metals and mineral fuels in Vermont at present. Vermont more than fulfills its per capita share of production of nonmetallic minerals (U.S. average consumption 11,740 pounds of nonmetallics per capita) and is a net exporter of nonmetallic mineral products. The value of Vermont mineral products is almost 1% of the gross State product (GSP) and is equal to about 4% of the entire value added by all manufacturing establishments in the State. In addition, manufacture of stone, clay, glass products, and primary metal industries represent about 6% of the total State manufacturing economy and employ somewhat more than 10% of manufacturing employees. Primary and fabricated metal working is an additional 3% of the manufacturing sector. Locally, impact may be even greater. For example, in Barre, 57 out of 73 manufacturing establishments turned out stone, clay, or glass products—primarily granite monuments. In Rutland County, one-fifth of the manufacturing establishments are engaged in the same business category (mostly marble finishing). Construction activity, which is heavily dependent upon availability of construction minerals, is an additional 5% of the GSP of Vermont.

Of Vermont's approximately 130,000 industrial workers, about 1,400 are employed at mining establishments; another 2,200 at stone, clay, and glass plants; and more than 5,000 others in the primary and fabricated metals industries.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Vermont Industrial Products, a subsidiary of Vermont Asbestos Group, Inc. (VAG), started construction on a plant at Morrisville to make wallboard out of rejected fractions from the VAG asbestos mill at Lowell. The new facility will initially utilize about 2,000 tons of raw material each year, with a potential to use 14,000 tons annually. VAG has also completed extensive modifications to meet standards for ambient air quality and successfully completed limited drilling to locate new extensions of the asbestos body. The firm plans 6,000 additional feet of diamond drilling in 1978.

During 1977 there were several announcements of interest in, or tenders to purchase VAG, Inc. Among those mentioned at various times were Eastern Magnesia Talc Co., Engelhard Minerals, Norman Rolband of Sterling Trust Co., and a group lead by Jerome Hammang the President of VAG, Inc.

The asbestos industry was faced with increasing environmental and health concerns about the effect of asbestos-bearing dust on the health of persons working with asbestos-bearing products and about possible effects on the general public. The VAG asbestos mine and mill were directly affected by announced new Federal industrial working space air standards of two fibers per milliliter of air in place of five fibers per milliliter.

Cement.—Vermont has no cement producing plants, importing all of the commodity it needs. Bureau of Mines data indicated that 131,000 short tons of portland cement and 6,000 short tons of prepared masonry cement were shipped to Vermont destinations in 1977. These compared, respectively, with 109,000 short tons and 5,000 short tons in 1976.

Gem Stones.—The value of gem stones and mineral specimens collected was estimated at several thousand dollars. The most popular collecting localities were listed in Vermont Geological Survey Special Publication No. 2, "Mineral Collecting in Vermont," by R. W. Grant. The report can be purchased for $5 from the Vermont Department of Libraries, at Montpelier.

Kaolin.—There has been renewed interest recently in reviving mining of Vermont kaolin. One firm has tentative plans to utilize wood chips for kiln power if the proposed revival reaches project stage.

Phosphate.—An intraformational breccia in northwestern Vermont was being prospected as a potential source of phosphate and uranium. A single 39-pound sample analyzed by the Bureau of Mines contained more than 20% P_2O_5 and 0.04% U_3O_8 contained in hydrous apatite modules.

Sand and Gravel.—Sand and gravel production increased 43% in quantity and 55% in value. Average value per ton was $1.71 ($1.58 in 1976). Production from 53 operations totaled 3.4 million tons with a value of $5.8 million. Leading counties were Chittenden, Bennington, Windsor, and Orleans. Leading commercial producers were Hinesburg Sand and Gravel Co., Inc., Calkins Construction, Inc., M & T Sand and Gravel Co., S. T. Griswold, Inc., and Burgess Bros. Inc.

The Vermont Department of Highways purchased sand and gravel from commercial producers and contracted for production as part of construction and maintenance projects. Its own crews produced sand for ice control and gravel for routine paving and maintenance.

Table 5.—Vermont: Construction sand and gravel sold or used by producers

	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	1,332	$1,579	$1.19	1,117	$1,853	$1.66
Gravel	1,049	2,181	2.08	2,288	3,984	1.74
Total or average[1]	2,379	3,758	1.58	3,405	5,837	1.71

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Vermont: Construction sand and gravel sold or used, by major use category

Use	1976			1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	823	$1,553	$1.89	837	$1,728	$2.06
Concrete products (cement blocks, bricks, pipe, etc.)	159	330	2.08	263	552	2.10
Asphaltic concrete aggregates and other bituminous mixtures	372	817	2.20	595	1,183	1.99
Roadbase and coverings	497	524	1.05	1,162	1,776	1.53
Fill	322	280	.87	355	370	1.04
Railroad ballast[1]	--	--	--	W	W	3.31
Other uses	208	256	1.23	194	229	1.07
Total or average[2]	2,379	3,758	1.58	3,405	5,837	1.71

[1] Railroad ballast included with "Other uses."

[2] Data may not add to totals shown because of independent rounding.

Stone.—Nineteen companies quarried dimension stone at 28 quarries for rough monumental stone, rough blocks, dressed flagging, sawed building stone, and other uses. Output remained constant at 121,000 tons valued at $14,561,000. Leading companies were Rock of Ages Corp., Vermont Marble Co., and Wells-Lamson Quarry Co., Inc. Eight companies crushed stone at 25 quarries for roadstone, roadbase stone, bituminous aggregate, riprap, surface treatment aggregate, and other uses. Output expanded 14% to 2.12 million tons valued at $12.63 million. Leading producers were the Vermont Highway Department, Frank W. Whitcomb Construction Corp., and Shelborne Limestone Corp.

Among the States, Vermont ranked second in output of dimension granite, dimension marble, and dimension slate, and ranked fourth in output of total dimension stone.

Mineral waste disposal and recycling of mineral waste piles are of great concern in Vermont, and in 1977, Governor Snelling sought the Federal Bureau of Mines assistance to develop economical uses for slate wastes. During the year, the Bureau's Tuscaloosa (Ala.) Metallurgy Research Center worked on development of several promising products that should be of interest in Vermont, including glass-ceramic abrasive-resistant tiles, skid-resistant scoriaceous highway surfacing aggregates, and glass fiber that is highly resistant to attack from alkalies.

The granite industry started the year plagued by the severe winter of 1976-77, and ended the year faced with the probability of new, more restrictive limits to be placed upon noise levels in granite finishing shops. Interest was noted in separating used silicon carbide abrasive from granite waste sludges so that the carbide could substitute for ferrosilicon in some steel batches. The Bureau of Mines in recent years conducted successful research on recovering silicon carbide from Barre sludges.

The Vermont Occupational Safety and Health Administration (VOSHA) announced that dust standards for Barre granite sheds would be lowered from 100 micrograms of quartz per cubic meter of air to 50 micrograms.

Rock of Ages Corp. had its new Adams quarry fully developed, featuring truck haulage directly from the pit floor.

Vermont Marble Co. (Pleuss-Stauffer Inc.) placed in operation a new gang saw mill and craneway in its underground Danby quarry and had under construction a ground calcium carbonate mill at Florence to add substantially to the firm's existing production capacity for super-fine industrial fillers, coatings, and extenders.

Vermont Marble Co. operated three dimension stone quarries during the year: Danby (white), Isle LaMotte (black), and Roxbury (verde antique). Ground marble (including limestone) production increased substantially. The product was used principally for filler in items such as plastics, synthetic rubber, and chewing gum. As prices of plastic feedstocks increased, fabricators were tending to increase percentages of filler in their products.

Rock of Ages Corp. operated five quarries (in gray granite), a finishing plant at Barre, and a sixth quarry (in white granite) at Bethel.

Table 7.—Vermont: Dimension stone[1] sold or used by producers, by use

Use	1976			1977		
	Quantity (short tons)	Cubic feet (thousands)	Value (thousands)	Quantity (short tons)	Cubic feet (thousands)	Value (thousands)
Rough monumental	79,660	816	$7,043	78,340	804	$8,125
Dressed flagging	12,060	121	404	10,830	119	387
Flooring	3,835	38	564	3,835	42	564
Rough blocks	18,640	206	1,951	2,574	29	173
Roofing slate	1,553	16	386	1,675	18	438
House stone veneer	W	W	W	1,550	17	318
Other uses[2]	5,493	63	1,133	21,759	245	4,556
Total[3]	121,200	1,261	11,480	120,560	1,276	14,560

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes granite, slate, and marble.

[2] Includes stone used in sawed stone (1977), dressed monumental, irregular shaped stone (1977), structural and sanitary purposes, rough flagging, other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 8.—Vermont: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	72	146	545	1,175
Bituminous aggregate	115	261	539	1,482
Surface treatment aggregate	226	530	W	W
Roadstone	631	1,604	265	725
Concrete aggregate	79	196	W	W
Railroad ballast	74	172	W	W
Riprap and jetty stone	300	546	28	66
Fill	--	--	8	16
Abrasives	--	--	([2])	1
Other uses[3]	360	7,506	737	9,169
Total[4]	1,857	10,960	2,123	12,630

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, miscellaneous stone, granite, sandstone, traprock (1976), and marble (1976).

[2] Less than 1/2 unit.

[3] Includes whiting, agricultural limestone, other filler, terrazzo and exposed aggregate, mineral food, paper manufacture, roofing granules, macadam aggregate (1977), other uses, and uses indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

Talc.—Three companies mined and ground talc in 1977. Production increased over 1976. The ground talc was sold and used for toilet preparations, plastics, rubber, paper, paint, insecticides, asphalt filler, refractories, foundry facings, and for export. Vermont Soapstone Co., Inc., fabricated soapstone stoves, griddles, and other products in their Perkinsville plant. Windsor Minerals had a new $3 million talc mill and mining complex near Ludlow fully operational.

Talc firms were concerned about possible effects upon their future operations if the Environmental Protection Agency (EPA) should detect any fibrous minerals in their products due to concerns about health effects from asbestiform minerals in the environment.

METALS

Copper.—Prospecting for copper and other base metals continued during 1977. Areas of interest were located in the eastern Vemont copper belt (the so-called "New Brunswick-Connecticut Valley Trend") and near Berkshire and Wolcott.

MINERAL FUELS

Uranium.—Several private firms and the Department of Energy (DOE) continued active interest in the uranium potential of the State. DOE contractors have carried out both airborne geophysical surveys and limited hydrogeological sampling that has confirmed the existence of many unevaluated anomalies. A specimen of uranium-phosphate breccia from the Clarendon Springs Formation was analyzed by the Bureau of Mines and proved to contain more than 20% P_2O_5 and more than 0.04% U_3O_8.

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[1] State Liaison Officer, Bureau of Mines, Newmarket, N.H.

[2] State geologist, Montpelier, Vt.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos: Vermont Asbestos Group, Inc.[1]	Box 70 Hyde Park, VT 05655	Pit	Orleans.
Sand and gravel:			
Burgess Bros. Inc	Bennington, VT 05201	Pit	Bennington.
Calkins Construction Inc	Lyndonville, VT 05851	Pit	Orleans.
S. T. Griswold, Inc	Williston, VT 05495	Pit	Chittenden.
Hinesburg Sand & Gravel	Hinesburg, VT 05461	Pit	Do.
M&T Sand & Gravel	Swanton, VT 05488	Pit	Franklin.
Stone:			
Granite (dimension):			
Rock of Ages Corp	Barre, VT 05641	Quarries	Orange, Washington, Windsor.
Wells-Lamson Quarry Co. Inc.[2]	do.	Quarry	Washington.
Limestone, dolomite, marble (crushed, ground, broken):			
Shelburne Limestone Corp	30 Jewett St. Shelburne, VT 05765	do	Chittenden and Franklin.
Vermarco	Proctor, VT 05765	Quarry	Rutland.
Frank W. Whitcomb Construction Corp.	Box 429 Bellows Falls, VT 05101	do	Chittenden.
White Pigment Corp	Proctor, VT 05765	Quarries	Addison and Rutland.
Marble (dimension):			
Vermont Marble Co.[3]	do.	do	Grand Isle, Rutland, Windsor.
Slate (dimension):			
John G. Hadeka	Poultney, VT 05764	Quarry	Rutland.
Hilltop Slate Co	Middle Granville, NY 12849	do	Do.
Taran Bros. Inc	North Poultney, VT 05764	do	Do.
Tatko Bros. Slate Co	do.	do	Do.
Talc:			
Eastern Magnesia Talc Co	Johnston, VT 05656	Underground mines.	Lamoille.
Vermont Talc, Inc	Chester, VT 05143	do	Windham.
Windsor Minerals, Inc	Windsor, VT 05089	do	Windsor.

[1] Also miscellaneous stone.
[2] Also crushed and broken granite.
[3] Also crushed and broken limestone and dolomite.

The Mineral Industry of Virginia

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Virginia Division of Mineral Resources for collecting information on all minerals except fuels.

By Lawrence E. Shirley[1] and D. C. Le Van[2]

Virginia's total mineral production value in 1977 was $1,341.7 million, an increase of $181 million, or 16%, over that of 1976. Principal mineral commodities produced, in descending order of value, were coal, stone, lime, cement, sand and gravel, natural gas, zinc, and kyanite. These eight mineral commodities accounted for 99% of the total mineral production value; all, except portland cement, showed increased value during the year.

Virginia led the Nation in kyanite production and was the only State that produced aplite.

Legislation and Government Programs.—The Division of Mineral Resources of the Virginia Department of Conservation and Economic Development continued its geologic and mineral-resource evaluation program throughout the year. One of its publications was a directory of the mineral industry, prepared and issued annually.[3] The 1977 directory lists 254 companies and individuals on record as of March 15, 1977, exclusive of coal-mine operators. The listing includes portable plants, some captive and intermittent operations, and some processors of out-of-State or imported materials. The names of producers and processors are arranged by county or city under the appropriate raw material or commodity.

Other 1977 publications by the Division of Mineral Resources included a regional gravity survey of approximately 5,300 square miles in southwestern Virginia[4] and a gravity map of the entire State at a scale of 1:500,000.[5] A bibliography of Virginia geology and mineral resources covering 1960-69 was published.[6]

Other significant studies included geologic quadrangle investigations with text and maps.[7] Individual mineral commodities of economic significance within the quadrangles were discussed. The Division of Mineral Resources continued its cooperative programs with the U.S. Bureau of Mines on the collection of mineral industry statistics and the sampling and testing of clays and other raw materials in the State.

Table 1.—Mineral production in Virginia[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	862	$1,210	890	$1,294
Coal (bituminous) do	39,996	964,669	37,624	1,115,438
Gem stones	NA	12	NA	12
Lead (recoverable content of ores, etc.) short tons	1,946	899	2,203	1,352
Lime thousand short tons	878	25,993	846	28,767
Natural gas million cubic feet	6,937	7,908	8,220	10,357

See footnotes at end of table.

Table 1.—Mineral production in Virginia[1] —Continued

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Petroleum (crude) thousand 42-gallon barrels	3	W	W	W
Sand and gravel[2] thousand short tons	10,191	$23,089	10,447	$24,605
Stone:				
Crushed do.	36,121	89,965	41,707	109,737
Dimension do.	11	1,758	10	1,864
Zinc (recoverable content of ores, etc.) short tons	11,241	8,319	13,272	9,131
Combined value of aplite, cement (masonry and portland), gypsum, kyanite, sand and gravel (industrial), silver, talc (soapstone), and items indicated by symbol W	XX	36,823	XX	39,129
Total	XX	1,160,645	XX	1,341,686
Total 1967 constant dollars	XX	595,759	XX	^{P}662,256

^{P}Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes industrial sand and gravel; value included in "Combined value" figure.

Table 2.—Value of mineral production in Virginia, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Accomack	$146	$163	Sand and gravel.
Albemarle	W	W	Stone, sand and gravel.
Alleghany	130	W	Stone.
Amherst	W	W	Stone, sand and gravel.
Appomattox	327	W	Stone.
Augusta	W	W	Stone, sand and gravel.
Bedford	W	W	Stone.
Bland	96	W	Do.
Botetourt	W	W	Cement, stone, clays.
Brunswick	W	W	Stone, clays.
Buchanan	W	--	
Buckingham	W	W	Kyanite, stone.
Campbell	2,238	2,830	Stone, sand and gravel.
Caroline	638	753	Sand and gravel.
Charles City	W	W	Do.
Charlottsville (city)	17	W	Do.
Chesapeake (city)	W	W	Cement, sand and gravel.
Chesterfield	6,044	W	Sand and gravel, stone, clays.
Clarke	W	W	Stone.
Craig	462	175	Sand and gravel.
Culpeper	W	W	Stone.
Dickenson	W	--	
Dinwiddie	W	W	Stone.
Fairfax	W	W	Stone, sand and gravel.
Fauquier	W	1,857	Stone.
Floyd	20	W	Do.
Franklin	W	W	Stone, soapstone.
Frederick	W	W	Stone, lime.
Giles	W	W	Lime, stone.
Gloucester	38	36	Sand and gravel.
Goochland	3,100	3,584	Stone.
Grayson	439	W	Stone, sand and gravel.
Greensville	W	W	Stone, clays.
Halifax	W	W	Stone, sand and gravel.
Hanover	W	W	Stone, aplite, sand.
Henrico	9,145	10,746	Sand and gravel, stone.
Henry	W	1,704	Stone, sand and gravel.
Highland	97	W	Stone.
Isle of Wight	W	W	Sand and gravel, lime, stone.
James City	W	--	
King George	W	W	Sand and gravel.
King William	W	W	Do.
Lancaster	W	24	Do.
Lee	W	W	Stone.
Loudoun	6,259	7,656	Do.
Middlesex	5	11	Sand and gravel.
Montgomery	817	W	Stone, clays.
Nansemond	14	W	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Virginia, by county[1] —Continued

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Nelson	W	W	Aplite, stone, sand and gravel.
New Kent	W	$225	Sand and gravel.
Newport News (city)	W	W	Do.
Northampton	$12	W	Do.
Northumberland	W	18	Do.
Nottaway	W	1,651	Stone.
Orange	W	W	Clays.
Page	W	W	Stone.
Pittsylvania	W	W	Stone, sand and gravel.
Powhatan	W	W	Stone.
Prince Edward	W	W	Kyanite, stone.
Prince George	W	W	Sand and gravel.
Prince William	W	W	Stone, clays.
Pulaski	W	W	Stone.
Rappahannock	W	W	Do.
Richmond (city)	W	W	Stone, clays.
Roanoke	2,819	W	Do.
Rockbridge	W	W	Do.
Rockingham	W	W	Stone, sand and gravel.
Russell	4,411	5,808	Stone.
Scott	1,806	2,091	Do.
Shenandoah	W	W	Lime, stone.
Smyth	W	W	Stone, clays, sand and gravel.
Southampton	W	175	Sand and gravel.
Spotsylvania	W	W	Stone, sand and gravel.
Stafford	W	W	Sand and gravel.
Suffolk (city)	W	W	Do.
Surry	W	W	Do.
Tazewell	W	W	Stone, natural gas, clays.
Virginia Beach (city)	1,219	2,074	Sand and gravel.
Warren	W	W	Cement, stone, sand and gravel.
Washington	W	W	Stone, gypsum.
Westmoreland	67	92	Sand and gravel.
Wise	W	W	Stone, natural gas.
Wythe	W	15,777	Zinc, stone, lead, silver.
York	88	W	Sand and gravel.
Undistributed[2]	1,120,179	1,284,233	
Total[3]	1,160,645	1,341,686	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] The following counties or cities are not listed because no production was reported: Alexandria (city), Amelia, Arlington, Bath, Bedford (city), Bristol (city), Buena Vista (city), Carroll, Charlotte, Clifton Forge (city), Colonial Heights (city), Covington (city), Cumberland, Danville (city), Emporia (city), Essex, Fairfax (city), Falls Church (city), Fluvanna, Franklin (city), Fredericksburg (city), Galax (city), Greene, Hampton (city), Harrisonburg (city), Hopewell (city), King and Queen, Lexington (city), Louisa, Lunenburg, Lynchburg (city), Madison, Martinsville (city), Mathews, Mecklinburg, Norfolk (city), Norton (city), Patrick, Petersburg (city), Portsmouth (city), Radford (city), Richmond, Roanoke (city), Salem (city), South Boston (city), Staunton (city), Sussex, Waynesboro (city), Williamsburg (city), and Winchester (city).

[2] Includes gem stones, coal, natural gas, petroleum, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Virginia business activity

		1976	1977p	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,314.0	2,383.0	+3.0
Unemployment	do	136.0	127.0	-6.6
Employment (nonagricultural):				
Mining	do	21.8	21.8	--
Manufacturing	do	387.8	400.0	+3.1
Contract construction	do	111.8	113.7	+1.7
Transportation and public utilities	do	105.6	106.9	+1.2
Wholesale and retail trade	do	386.7	399.4	+3.3
Finance, insurance, real estate	do	86.3	90.3	+4.6
Services	do	312.8	324.9	+3.9
Government	do	435.4	454.7	+4.4
Total nonagricultural employment	do	1,848.2	1,911.7	+3.4

See footnotes at end of table.

Table 3.—Indicators of Virginia business activity —Continued

	1976	1977^p	Change, percent
Personal income:			
Total ---- millions	$31,899	$35,246	+10.5
Per capita	$6,314	$6,865	+8.7
Construction activity:			
Number of private and public residential units authorized	39,862	59,946	+50.4
Value of nonresidential construction ---- millions	$473.5	$521.3	+10.1
Value of State road contract awards ---- do	$257.0	$294.0	+14.4
Shipments of portland and masonry cement to and within the State thousand short tons	1,781	1,829	+2.7
Mineral production value:			
Total crude mineral value ---- millions	$1,160.6	$1,341.7	+15.6
Value per capita, resident population	$231	$261	+13.0
Value per square mile	$28,435	$32,871	+15.6

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

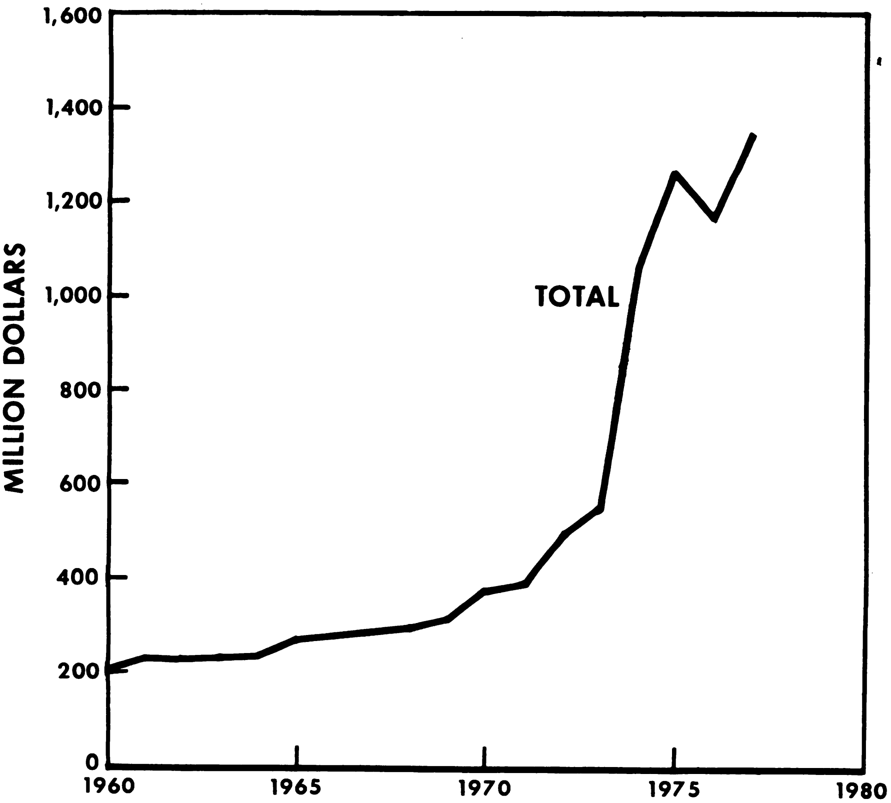

Figure 1.—Total value of mineral production in Virginia.

The Division of Mined Land Reclamation of the Virginia Department of Conservation and Economic Development published a set of regulations pertaining to the surface mining of coal. The amended regulations were adopted by the Virginia Department of Conservation and Economic Development and published in the form of a reclamation manual, which described the law and regulations and included revegetation guidelines, and a drainage handbook to be used by surface-coal-mine operators.

The Division of Mines and Quarries of the Virginia Department of Labor and Industry was active throughout 1977 in its mine-inspection program. During the year, the division was working on amended oil and gas rules; public hearings were held on the proposed rules near the end of the year. Other legislative proposals were made for amendments to the mining laws within the State, but action was not completed. The division continued its collection of information on production, equipment used in mines, employment data, capital expenditures, and other pertinent information on coal mining and nonmetallic mining and quarrying operations throughout the State.

In 1977, Virginia was in its third year of development of a coastal zone management plan. In 1972, the U.S. Congress passed the Federal Coastal Zone Management Act of 1972, which encouraged each coastal State to develop land- and water-use programs in the coastal zone areas under its jurisdiction. Virginia initiated coastal resources management planning in December 1974. In 1977, the Office of the Secretary of Commerce and Resources sponsored a workshop on Virginia's Coastal Resources Program to develop specific recommendations for the management of Virginia's coastal resources.

In 1977, the U.S. Forest Service began identification of roadless and undeveloped areas in the national forests of Virginia. The inventory made by the Forest Service designated 203,749 acres in 29 areas in 2 national forests of the State for possible inclusion in the Roadless Area Review and Evaluation Program (RARE II). Fifteen of the areas were in the Jefferson National Forest and 14 areas were in the George Washington National Forest. National forest land designated as wilderness and being considered in the RARE II program amounts to 13.2% of the national forest land in the State. After additional study and public hearings on proposed RARE II areas, final recommendations will be passed along to Congress, possibly in late 1978 or early 1979, for further debate, study, and final action.

Trends and Developments.—In Louisa County, two companies that have proposed to mine vermiculite continued their efforts throughout the year to obtain the necessary permits to begin mining operations. At yearend, because of environmental issues, it remained unclear when the companies could begin operations.

The Hampton Roads Energy Co. is continuing its 3-year effort to build a $550 million oil refinery on the Elizabeth River in the Portsmouth area. The refinery is slated to process 175,000 barrels of imported crude oil per day with a daily output of 7.3 million gallons of gasoline. To date, the company has spent an estimated $2.2 million developing plans for the refinery and seeking permits, and $5.5 million for the land on which to locate the refinery. Special-interest groups have delayed the issuance of the necessary permits.

Brown & Root Corp.'s plan to build a large industrial complex on the Eastern Shore near Cape Charles had not materialized at yearend. The Texas-based engineering and construction firm announced in 1974 that it had purchased 2,000 acres near Cape Charles and planned to manufacture offshore oil-drilling platforms and related structures on the site. The new plant, if constructed, would employ 1,800 persons.

During the year, a serious water shortage was predicted for the Norfolk-Virginia Beach-Hampton Roads area by 1980. During 1977, the Army Corps of Engineers, as a result of permit applications, began studies to alleviate the critical water needs in southeastern Virginia. At yearend, the Norfolk District of the Corps was studying five proposals that might prevent the water shortage. Two of the proposals related to drawing water from the Roanoke and Chowan Rivers in North Carolina and transporting the water to southeastern Virginia; both proposals have been strongly opposed by North Carolina. Another proposal included a combination plan of purchasing treated water from the Appomattox River Authority and constructing a lake (to be called Lake Genito), with subsequent withdrawal of raw water. Other proposals include the development of desalinization plants as an unlimited source of potable water for the Tidewater area. The Corps estimates the cost of desalinization facilities to be $222.3 million, with a 50-year annual amortization and operational cost of $22.8 million. The plants would take water from the Atlantic and remove the salt. Before making a final recommendation to the U.S. Congress on a water plan, the Corps was to hold another workshop and public hearing in early 1978.

Virginia's port development is an important economic factor in the State. Waterborne commerce has grown dramatically since the 1960's, placing the Hampton Roads ports among the Nation's most active in exports. Hampton Roads encompasses five terminals in the cities of Norfolk, Portsmouth, Newport News, and Chesapeake. Since 1975, these five terminals have been operated by the Virginia Ports Authority (VPA) in Norfolk.

During 1976, the latest year for which complete statistics are available, total trade through Virginia ports was 52.4 million tons of bulk and general cargo valued at $8 billion. Total exports during the year were 40.3 million tons valued at $5.2 billion, and total imports were 12.1 million tons valued at $2.8 billion.

According to VPA, about 90% of the oceangoing U.S. exports of bituminous coal move through the port of Hampton Roads, the largest coal-handling complex in the world. The coal exported from Virginia is handled at two terminals, both privately leased. N&W Railway Co. leases the Lambert and Sewells Point terminal at Norfolk, and the Chessie System leases the Piers "B" and "C" terminal at Newport News. During 1977, 24.4 million tons of mostly high-grade metallurgical coal valued at $1.3 billion was exported through these two facilities, compared with 31.9 million tons in 1976. The average price for this coal was over $53 per ton, attesting to its high quality. About 55% of the coal went to Japan; the balance went to Western European countries and others. Japan, the largest buyer of U.S. metallurgical coal in the past, has found other coal sources closer to home and has cut its purchases of U.S. coal in the past 2 years.

Other exports classified as fuels handled at Virginia ports included pitch and asphalt, coking coal, small tonnages of distillate fuels, natural gas liquids, lubricating oils and greases, and petroleum jelly and waxes. Total exports of these mineral fuels, lubricants, and related materials during the year were 24.5 million tons valued at $1.3 billion. Natural abrasives and crude minerals are the other mineral products exported.

Imports in 1977 through the Hampton Roads terminals included crude petroleum, gasoline, jet fuel, distillate fuel oils, and several small tonnages of peat, coking coal, and lubricating oils and greases. One of the fastest growing imports has been residual fuel oil for residential and industrial heating; 6.2 million tons valued at $471.0 million was imported during 1977. Total imports of mineral fuels, lubricants, and related materials during the year were 9.4 million tons valued at $752.6 million.

In 1977, there were 112 announcements by manufacturing firms of plans for new plants or expansions in the State, representing the creation of 9,100 new jobs. Thirteen of the announcements represented major investments in Virginia by foreign corporations. Mineral-related operations announcing new plants or expansions included Brockway Glass Co.'s new container-glass plant at Danville, slated to cost $27 million, and Reynolds Metals Co.'s $16 million expansions at Richmond and Grottoes.

Brockway Glass Co., a Pennsylvania-based manufacturer of glass containers, announced about midyear that it would build a new plant in Danville. The facility initially will have a single furnace for melting clear glass and will be capable of producing about 400 tons per day, enough to make an estimated 425 million glass bottles per year. The new plant will be a major supplier of containers to the food, soft drink, and brewing industries of Virginia, North Carolina, and other nearby States.

Onduline, U.S.A., Inc., a corrugated asphalt roofing and siding manufacturing company, opened a new plant near Massaponax, 5 miles south of Fredericksburg, during the first quarter of the year. Onduline, U.S.A., is owned by Omnium Francais Industriel et Commercial of Paris, France, and Media General, Inc., a diversified communications company, which has its headquarters in Richmond. The roofing and siding is made from processed minerals, recycled waste paper, and other organic material. As an alternative to corrugated-metal roofing, Onduline sheets are used primarily for farms, commercial, and industrial buildings and in some types of residential housing.

Island Creek Coal Co. completed its new Virginia Pocahontas mine 5 in Buchanan County during the year. Principal development work consisted of sinking three main shafts, and building an ultramodern coal-preparation plant and permanent hoisting facilities. The company also began preliminary work on Virginia Pocahontas mine 6 on Garden Creek. The company began operations in the area in 1964 with the opening of the Beatrice mine and, since that time, has completed Virginia Pocahontas mines 1, 2, 3, 4, and 5. Each mine has a lifespan of 40 to 50 years.

In another development, Island Creek announced an agreement with Romania to sell that country 14 million tons of metallurgical coal at cost and arranged an option to sell an additional 13.3 million tons at the market price. The coal was slated to come from a mine under development by Island Creek in Buchanan County. The Romanian Mineral Import-Export Ministry advanced $53 million for development of the mine. Romania is buying the high-quality coal to fuel its iron and steel industry.

Employment and Injuries.—Total mining employment in Virginia in 1977 was about 22,000. Data on mining employment in the State are compiled and published in the Annual Report by the Division of Mines and Quarries of the Virginia Department of Labor and Industry. According to that report, there were 1,760 quarry and metal mine employees in over 300 operations throughout the State in 1977. Plant employment totaled 2,807, and there were 815 office workers in metal mining and in the mining and quarrying of nonmetallic minerals in 1977.

The 1,068 coal mines operated in 7 Southwestern counties of the State employed 15,742 production workers and 806 office workers; of the production workers, 11,556 were utilized in underground production of coal and the remaining 4,186 were employed in surface coal mining operations.

According to the Annual Report for 1977 on Administration of the Federal Metal and Nonmetallic Mine Safety Act (Public Law 89-577), Virginia has 220 mining and milling operations that were active throughout the year. Mining Enforcement and Safety Administration (MESA) inspectors conducted 187 regular and 24 spot inspections of metal and nonmetal mines and mills during 1977. Preliminary data indicated that only one fatality was reported in the State during the year. There were 34 disabling injuries in underground mines, 65 in surface mines, and 48 in mills during 1977.

During 1977, a State Plan Agreement was in effect between MESA and the Commonwealth of Virginia. Under the agreement, the State is given the authority to issue notices of violations and withdrawal orders, or otherwise enforce health and safety standards. The State is required, under the agreement, to inspect all underground mines at least four times a year and all surface operations at least once a year.

The Federal Mine Safety and Health Act of 1977 (Public Law 91-173 as amended by Public Law 95-164), which became effective March 9, 1978, does not provide for State plans. Therefore, on that date all State plans were no longer in effect and MESA inspectors were to perform the inspections in the State Plan States required by the new law.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—In terms of mineral production value, coal continued to be the leading mineral produced in the State. The amount of coal mined in the State totaled 37.6 million tons, 2.4 million tons less than that mined in 1976. The decrease in production was attributed mainly to strikes, adverse market conditions for metallurgical-grade coal, and the Surface Mine Act of 1977, which reportedly lowered the amount of surface-mine coal produced.

Buchanan, Dickenson, Tazewell, and Wise Counties were the four leading coal-producing counties in the State. Buchanan County had 45% of the total production; Dickenson County accounted for 13% of the total; and all others accounted for the remaining 13% of the total.

Output of coal mined by the machine method was 60% of the total, with the continuous miner machine accounting for 36%.

The number of mines operated during the year totaled 1,068; and 15,742 production workers were employed in both surface and underground operations, earning a total of $247.8 million in wages. Capital expenditures totaled $112.0 million.

Natural Gas and Petroleum.—Natural gas production during 1977 showed a moderate increase of 18.5% in output, but the value increased sharply to 31% over that of 1976. Total production was 8,220 million cubic feet valued at $10.4 million. In terms of value, natural gas was the fifth leading mineral commodity produced in the State.

According to the 1977 Annual Report of the Virginia Department of Labor and Industry, Division of Mines and Quarries, natural gas production came from 202 wells in Buchanan, Dickenson, Tazewell, and Wise Counties by eight companies. Leading companies in output were Columbia Gas Transmission Corp. with 90 wells producing over 54% of the total output, and Philadelphia Oil Co., with 40 wells producing 33% of the total output.

Crude oil production declined during 1977 with a corresponding decline in value. Production was reported from eight stripper wells in two fields.

NONMETALS

Aplite.—Virginia was the only State in the Nation with recorded production of aplite in 1977. Total output remained about the same as that of the previous year, but the value increased 54% above that of 1976, due to price increases. The Feldspar Corp. operated a mine and plant near Montpelier, Hanover County, and IMC Chemical Group, Inc., operated a mine and plant near Piney River in Nelson County. Most of the material was used by the flat-glass and container-glass industries.

Cement.—In terms of value, cement was the third leading nonmetal mineral commodity produced in 1977. Combined cement production showed only slight changes from that of 1976. Masonry cement output increased 10% and value, 24% over that of 1976. However, portland cement production declined slightly and value decreased 8% below that of 1976.

Lone Star Industries, Inc., operated its Roanoke Cement plant near Cloverdale and according to Lone Star's 1977 Annual Report, the newly expanded Roanoke plant sold all of its available production, and output gradually increased through the year to about 1 million tons. The Roanoke plant is among the largest and most efficient cement plants in the United States and has a rated capacity of 1.2 million tons annually.

Lone Star also operated its Norfolk grinding plant for cement clinker near the City of Chesapeake. In addition to its cement plants, Lone Star Industries is a large producer of crushed granite and sand and gravel at numerous locations in the eastern part of the State.

Riverton Corp. was the only other cement producer in the State during 1977. Riverton produced masonry cement only at its plant near Riverton, Warren County. In addition to quarries near its cement plant in Warren County, Riverton Corp. also produced limestone in Page and Shenandoah Counties, and operated a crushed stone operation in Fauquier County near Paris and a lime plant in Warren County.

Clays.—Common clay and shale production in 1977 showed a small increase over that of 1976. Total output was 890,000 short tons valued at $1.3 million compared to 862,000 tons valued at $1.2 million in 1976, an increase of 3% in output and 7% in value over that of the previous year. Production was by 8 companies at 14 mines in 11 counties and 1 city. Most of the clay and shale was unprocessed and used in the manufacture of facebrick and other heavy clay products. Other uses were for lightweight aggregate for the manufacture of concrete block, structural concrete, and for other purposes. Total material used in lightweight aggregate was 105,728 tons valued at $154,362. Principal producers, in descending order of output, were General Shale Products Corp. (three mines), Webster Brick Co., Inc. (two mines), and Weblite Corp. (one mine).

Table 4.—Virginia: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1973	1,646	1,886
1974	1,957	2,614
1975	819	1,152
1976	862	1,210
1977	890	1,294

Gem Stones.—Amateur collectors and rock enthusiasts continued collecting a variety of mineral specimens and semiprecious gems at various locations throughout the State. There were at least nine gem and mineral societies located at Colonial Heights, Bristol, Hampton, Norfolk, Mechanicsville, Roanoke, Waynesboro, Lynchburg, and Springfield. These organizations may be contacted for information on collecting localities and general information. Collectors are reminded that permission should be obtained before going on private property and extreme caution should be exercised around old abandoned mines and open shafts. Mine openings should never be entered without a competent guide.

Gypsum.—Gypsum production showed an increase of 11%, and value more than tripled over that of 1976. United States Gypsum Co. continued as the State's only producer of crude gypsum at mines near Plasterco, Washington County, and Chatham Hill, Smyth County. The company also calcined gypsum at a plant near Plasterco, and continued operating a calcining plant near Norfolk using imported gypsum and anhydrite for the manufacture of a variety of gypsum products.

Kyanite.—Virginia led the Nation in kyanite production in 1977. Kyanite output increased 9% and value, more than 24% over that of the previous year. Kyanite Mining Corp. operated mines and plants in Buckingham and Price Edward Counties.

During the year, Kyanite Mining Corp. placed in operation its third concentrating plant, located at East Ridge, near Willis Mountain. Plant construction began in 1975; and rated capacity was 100,000 short tons per year.

Lime.—Virginia's lime production decreased slightly below that of 1976. Total output was 846,000 short tons, valued at $28.8 million, compared to 878,000 short tons, valued at $26.0 million, in 1976. Hydrated lime output was 97,000 short tons, and quicklime production totaled 749,000 short tons. Seven companies produced lime in five counties. Leading companies, listed in descending order of production, were Chemstone Corp., in Shenandoah County, and National Gypsum Co. and Virginia Lime Co., both near Kimballton, Giles County. Principal uses for the lime produced in Virginia was as a metallurgical flux in the basic oxygen furnace (BOF) steelmaking process, in water purification, in pulp and paper manufacture, and in electric furnace production of steel.

In consumption of lime in 1977, Virginia received 216 combined short tons of quicklime and hydrated lime from other States.

Mica.—Imported mica was processed at two adjacent plants in the Newport News area. Asheville Mica Co. operated a mica-fabricating plant, and Mica Co. of Canada Inc. operated a plate-mica plant.

Nitrogen Compounds.—Allied Chemical Corp., Nitrogen Div., near Hopewell, produced ammonia, urea, ammonium nitrate, and ammonium sulfate from reformed natural gas. The materials produced were used primarily as ingredients in fertilizers.

Perlite.—Johns-Manville Sales Corp., Shenandoah County, expanded perlite from out-of-State sources at its Valley plant near Woodstock. Total output more than doubled over that of 1976. The expanded product was used in the manufacture of roof insulation board.

Table 5.—Virginia: Lime sold or used by producers, by use

Use	1976 Quantity (short tons)	1976 Value (thousands)	1977 Quantity (short tons)	1977 Value (thousands)
Steel, BOF	417,400	$12,250	359	$12,168
Paper and pulp	137,900	4,051	128,500	4,354
Water purification	86,070	2,590	110,100	3,730
Steel, electric	65,070	1,909	54,970	1,863
Steel, open-hearth	W	W	52,590	1,782
Sewage treatment	47,210	1,462	48,120	1,631
Mason's lime	--	--	43,430	1,742
Agriculture	7,600	266	7,250	274
Construction	12,060	370	W	W
Other uses[1]	104,300	3,094	41,770	1,221
Total[2]	877,600	25,993	845,700	28,767

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes other metallurgy, other chemical uses, sugar refining, tanning, finishing lime (1977), acid mine water, soil stabilization (1977), glass (1977), aluminum and bauxite (1976), and uses indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Sand and Gravel.—Total sand and gravel production in 1977, exclusive of that classified as industrial sand and gravel, increased 3% in quantity and 7% in value above those of 1976. Total output was 10.4 million short tons valued at $24.6 million, compared to 10.2 million short tons valued at $23.1 million in 1976. Sand and gravel, including industrial, was produced by 91 companies at 102 mines in 42 counties and/or independent cities.

Leading sand and gravel producers during the year were Lone Star Industries, Inc., with operations in Chesterfield, Henrico, and Prince George Counties; E. V. Williams Co., Inc. with two operations at Virginia Beach; Fredericksburg Sand & Gravel Co. with one operation in Stafford County; Sadler Materials Corp. with three operations in Prince George and Henrico Counties; and West Sand & Gravel Co., Inc. with two operations in Henrico and Rockingham Counties.

These five companies accounted for 60% of the total tonnage of sand and gravel and 69% of the total value during 1977. There were 54 operations throughout the State with production less than 25,000 tons, 21 operations producing between 25,000 and 100,000 tons, 14 operations producing between 100,000 and 200,000 tons, 11 operations producing between 200,000 and 1 million tons, and two operations with more than 1 million tons output.

Transportation of construction sand and gravel was 57% by truck, 34% by waterway, 7% by railroad, and the remaining 2% by other means.

Table 6.—Virginia: Sand and gravel sold or used by producers, by use

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	6,772	$14,167	$2.09
Gravel	3,675	10,438	2.84
Total or average	10,447	24,605	2.36
Industrial sand and gravel	W	W	W

W Withheld to avoid disclosing company proprietary data.

Table 7.—Virginia: Construction sand and gravel sold or used, by major use category

Use	1977		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	3,984	$10,806	$2.71
Concrete products	1,918	5,680	2.96
Asphaltic concrete	1,997	3,521	1.76
Roadbase and coverings	790	2,055	2.60
Fill	1,409	1,755	1.25
Other	349	788	2.26
Total or average	10,447	24,605	2.36

Soapstone.—Blue Ridge Talc Co. was the only producer of soapstone reporting production to the Bureau of Mines during 1977. Output and value declined below that of 1976.

Stone.—In terms of value, stone was the leading nonmetallic mineral commodity produced in the State. Among the States, Virginia led the Nation in output of crushed slate and ranked third in crushed granite and dimension slate.

Total stone output, including dimension and crushed stone, was 41.7 million short tons valued at $111.6 million, compared with 36.1 million tons valued at $91.7 million in 1976, an increase of 15% in tonnage and 22% in value.

Crushed stone was produced by 73 companies at 123 quarries for roadbase aggregate, other aggregate and roadstone, concrete aggregate, and other uses. Leading producers were Vulcan Materials Co., Luck Quarries, Inc., and Lone Star Industries, Inc.

Dimension stone was quarried by eight companies at eight quarries for roofing slate, dressed flagging, rough construction stone, structural shapes, and other uses. Output decreased to 9,931 tons valued at $1.9 million. Leading producers were LeSuer-Richmond Slate Corp., Arvonia-Buckingham Slate Co., Inc., and Leesville Stone Co., Inc.

Sulfur.—Hydrogen sulfide, recovered from gas, was converted to elemental sulfur

Table 8.—Virginia: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	12,120	28,220	16,040	39,010
Roadstone	5,161	12,060	5,689	13,940
Concrete aggregate	4,950	12,320	5,361	14,320
Bituminous aggregate	3,967	9,587	5,270	14,170
Surface treatment aggregate	2,323	5,547	2,116	5,789
Agricultural limestone	1,882	6,062	1,660	6,880
Cement manufacture	1,340	2,602	1,584	2,979
Lime manufacture	1,664	3,749	1,566	2,977
Macadam aggregate	537	1,174	531	1,237
Mine dusting	422	1,534	442	1,656
Railroad ballast	346	751	288	664
Riprap and jetty stone	136	472	208	677
Flux stone	345	804	207	435
Other filler	141	725	168	963
Soil conditioners	5	9	6	13
Bedding material	10	25	--	--
Other uses[2]	770	4,319	575	4,026
Total[3]	36,121	89,965	41,707	109,737

[1] Includes limestone, granite, traprock, sandstone, slate, other stone, marble, marl, and shell.

[2] Includes stone used in lightweight aggregate, glass manufacture, filter stone, mineral food, asphalt filler, terrazzo and exposed aggregate, and slate flour. Also roofing granules, chemicals, abrasives, and fill (1976 data included).

[3] Data may not add to totals shown because of independent rounding.

by the American Oil Co. at its Yorktown refinery. Total output and value decreased slightly below that of 1976.

According to the Standard Oil Co. (Indiana) Annual Report for 1977, Amoco refineries reduced energy consumption per barrel of crude oil by 1% in 1977 because of new facilities and improved operating practice. Work started during the year on new heat-recovery projects at the Yorktown refinery and three others in the company system.

In research and development, the company announced two refining process improvements concerning sulfur. In one, a process was developed to remove sulfur from catalytically cracked naphthas with minimum loss of octane. The other process reduces sulfur oxides emissions from fluid catalytic cracking regenerators. This technique is aimed at bringing most fluid cracking units into compliance with future governmental emission standards.

METALS

Ferroalloys.—Chemstone Corp., subsidiary of Englehard Minerals & Chemicals Corp., produced ferrovanadium from imported and domestic materials at its plant near Strasburg, Shenandoah County. Chemstone also operated a limestone quarry and lime plant nearby.

Iron Ore.—Huff Coal & Oil Co. shipped byproduct iron ore in the form of iron cinder from stocks previously obtained from Allied Chemical Corp.'s pyrrhotite processing operation in Pulaski County. No production was reported during the year.

Iron Oxide Pigment Materials.—Hoover Color Corp. mined and shipped crude iron oxide pigments from deposits in Pulaski County.

Two companies in two counties produced finished (natural and synthetic) iron oxide pigments and other iron oxide materials in 1977. Blue Ridge Talc Co. produced natural red iron oxide, burnt sienna, and ocher at its plant in Franklin County. Hoover Color Corp. produced natural brown iron oxide, burnt umber, raw umber, burnt sienna, raw sienna, and ocher at its plant in Pulaski County. Finished iron oxide pigments are used in printing inks, paint manufacture, and in several other products where coloring agents are used.

Lead and Zinc.—Lead and zinc concentrates were produced from ore mined by a single company in Wythe County. Lead production increased considerably over that of 1976; output increased 13% and value was over 50% higher than that of the previous year. Zinc production was also up; output increased 18% and value, 10% over that of 1976.

Magnetite.—Virginia Lime Co., a subsidiary of the Rangaire Corp., operated a magnetite-grinding plant near Kimballton, Giles County, using magnetite from out-of-State sources. The processed magnetite was used principally as a heavy media agent in coal preparation.

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[1] State Liaison Officer, Bureau of Mines, Raleigh, N.C.

[2] Geologist, Virginia Division of Mineral Resources, Charlottesville, Va.

[3] LeVan, D. C. Directory of the Mineral Industry in Virginia — 1977. Va. Div. Miner. Res. (Charlottesville, Va.), 1977, 52 pp.

[4] Johnson, S. S. Bouguer Gravity in Southwestern Virginia. Va. Div. Miner. Res. (Charlottesville, Va.), Pub. 6, 1977, 27 pp.

[5] Johnson, S. C. Gravity Map of Virginia, Simple Bouguer Anomaly. Va. Div. Miner. Res. (Charlottesville, Va.), 1977.

[6] Hoffer, F. B. Bibliography of Virginia Geology and Mineral Resources — 1960-69. Va. Div. Miner. Res. (Charlottesville, Va.), Pub. 1, 1977, 68 pp.

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Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Aplite (crude):			
The Feldspar Corp	Route 1, Box 23 Montpelier, VA 23192	Quarry and plant	Hanover.
IMC Chemical Group, Inc	Box 38 Piney River, VA 22964	do	Nelson.
Cement:			
Lone Star Industries, Inc.[1]	Box 27 Cloverdale, VA 24077	do	Botetourt.
Lone Star Industries, Inc	Box 5128 Chesapeake, VA 23320	Plant	Chesapeake (City).
Riverton Corp.[2]	Riverton, VA 22651	Quarry and plant	Warren.
Clays (miscellaneous and shale):			
Brick and Tile Corp. of Lawrenceville	Box 45 Lawrenceville, VA 23868	Pits and plant	Brunswick and Greensville.
General Shale Products Corp	Box 3547 Johnson City, TN 37601	do	Rockbridge, Smyth, Tazewell.
Old Virginia Brick Co., Inc	Box 508 Salem, VA 24153	Pits and plants	Roanoke and Montgomery.
Weblite Corp	Box 12887 Roanoke, VA 24004	Pit and plant	Botetourt.
Webster Brick Co., Inc	Box 12887 Roanoke, VA 24004	Pits and plants	Botetourt and Orange.
Coal (bituminous):			
Clinchfield Coal Co.[3]	Dante, VA 24237	Underground mines	Buchanan, Dickenson, Russell.
Island Creek Coal Co	Box 113 Keen Mountain, VA 24264	do	Buchanan.
Westmoreland Coal Co	Box 229 Big Stone Gap, VA 24219	do	Wise.
Coke:			
Jewell Coal & Coke Co	Dismal Route, Box 1 Vansant, VA 24656	Plant	Buchanan.
Ferroalloys:			
Chemstone Corp.[4]	Box 189 Strasburg, VA 22657	do	Shenandoah.
Gypsum:			
United States Gypsum Co	Box 4686 Norfolk, VA 23523	do	Norfolk (City).
Do	Route 1 Saltville, VA 24370	Mine and plant	Washington.
Iron oxide pigments (crude):			
Blue Ridge Talc Co., Inc.[5]	Box 39 Henry, VA 24102	Plant	Henry.
Hoover Color Corp	Box 218 Hiwassee, VA 24347	Mines and plant	Pulaski.
Lime:			
Battery Park Fish and Oyster Co	Box 57 Battery Park, VA 23304	Plant	Isle of Wight.
Chemstone Corp.[6]	Box 189 Strasburg, VA 22657	do	Shenandoah.
W. S. Frey Co., Inc	Box 65 Clearbrook, VA 22624	do	Frederick.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lime —Continued			
The Flintkote Co	Box 8 Stephens City, VA 22655	Plant	Frederick.
National Gypsum Co	Star Route 635 Ripplemead, VA 24150	do	Giles.
Virginia Lime Co	Star Route Ripplemead, VA 24150	do	Do.
Perlite, expanded:			
Johns-Manville Sales Corp	Box 442 Woodstock, VA 22644	do	Shenandoah.
Sand and gravel:			
Lone Star Industries, Inc	Box 3778 Richmond, VA 23229	Pits	Chesterfield, Henrico, Prince George.
Fredericksburg Sand & Gravel Co	Box 650 Culpepper, VA 22701	do	Stafford.
Sadler Materials Corp	Box 5607 Virginia Beach, VA 23455	do	Henrico and Prince George.
West Sand & Gravel Co., Inc	Box 6008 Richmond, VA 23222	do	Henrico and Rockingham.
E. V. Williams Co., Inc	Box 938 Norfolk, VA 23501	do	Virginia Beach (City).
Soapstone:			
Blue Ridge Talc Co.[7]	Box 39 Henry, VA 24102	Mine and plant	Franklin and Henry.
Stone:			
Lone Star Industries, Inc	977 Norfolk Square Norfolk, VA 23501	do	Brunswick, Chesterfield, Dinwiddie.
Luck Quarries, Inc	Box 4682 Richmond, VA 23229	do	Albemarle, Augusta, Fairfax, Goochland, Loudoun, Nottoway.
Vulcan Materials Co	Box 7506 Reynolds Sta. Winston Salem, NC 27109	do	Brunswick, Chesterfield, Fairfax, Goochland, Halifax, Pittsylvania, Prince William, Washington.

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[1] Also clays, sand and gravel, and stone.
[2] Masonry cement only; also produces limestone and lime.
[3] Also clays.
[4] Also lime.
[5] Also soapstone.
[6] Also ferroalloys.
[7] Also finished oxide pigments.

The Mineral Industry of Washington

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Washington Division of Geology and Earth Resources for collecting information on all minerals.

By Herbert R. Babitzke[1] and Doris E. Smith[2]

The total value of mineral production in Washington was $216 million in 1977. Significant production increases were noted for portland cement, the quantity and value of which increased 18% and 34%, respectively, over 1976 levels and crushed stone which increased 20% in quantity and 19% in value over the previous year's levels.

Table 1.—Mineral production in Washington[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	6	$334	W	W
Portland do	1,238	48,669	1,462	$65,281
Clays[2] do	381	1,141	309	1,091
Coal (bituminous) do	4,109	W	5,057	57,042
Gem stones	NA	168	NA	160
Gold troy ounces	W	W	24,006	3,560
Lead (recoverable content of ores, etc.) short tons	W	W	1,201	738
Peat thousand short tons	14	103	12	117
Sand and gravel do	19,813	36,017	18,505	39,124
Silver thousand troy ounces	W	W	121	557
Stone:				
Crushed thousand short tons	10,218	23,614	12,239	28,156
Dimension do	5	477	5	440
Zinc short tons	W	W	5,572	3,834
Combined value of clays (fire), copper, diatomite, gypsum, lime, olivine, pumice, talc, tungsten, uranium, and items indicated by symbol W	XX	76,699	XX	16,024
Total	XX	187,222	XX	216,124
Total 1967 constant dollars	XX	96,101	XX	[p]106,679

[p] Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes fire clay; included with "Combined value" figure.

Table 2.—Value of mineral production in Washington, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	W	$63	Stone, sand and gravel.
Asotin	$80	517	Do.
Benton	W	W	Do.
Chelan	715	1,421	Sand and gravel, stone.
Clallam	W	W	Stone, clays, sand and gravel.
Clark	784	W	Stone, sand and gravel, clays.
Columbia	687	102	Stone.
Cowlitz	909	916	Stone, sand and gravel.
Douglas	2,300	1,600	Stone.
Ferry	3,821	4,296	Gold, silver, stone, zinc, copper, lead.
Franklin	W	W	Sand and gravel, stone.
Garfield	39	88	Stone.
Grant	W	W	Diatomite, lime, stone, sand and gravel.
Grays Harbor	W	1,214	Sand and gravel, stone.
Island	306	359	Do.
Jefferson	W	W	Stone, sand and gravel.
King	W	54,962	Cement, sand and gravel, stone, clays, peat.
Kitsap	W	W	Sand and gravel, stone, peat.
Kittitas	W	W	Stone, sand and gravel, clays.
Klickitat	292	W	Sand and gravel, stone, pumice.
Lewis	W	W	Sand and gravel, stone.
Lincoln	W	318	Do.
Mason	W	W	Stone, sand and gravel.
Okanogan	321	679	Stone, sand and gravel, gold, gypsum, silver.
Pacific	251	613	Stone.
Pend Oreille	17,914	13,886	Cement, zinc, stone, lead, sand and gravel, silver, copper, gold.
Pierce	W	W	Sand and gravel, lime, stone, clays.
San Juan	W	W	Sand and gravel.
Skagit	W	W	Olivine, sand and gravel, stone, talc.
Skamania	634	390	Stone, sand and gravel.
Snohomish	W	W	Sand and gravel, stone, peat, clays.
Spokane	W	W	Stone, sand and gravel, clays, peat.
Stevens	9,495	11,023	Uranium, stone, sand and gravel, tungsten, clays, silver, copper, lead, gold.
Thurston	W	W	Sand and gravel, stone, peat.
Wahkiakum	W	10	Stone.
Walla Walla	W	950	Sand and gravel, stone.
Whatcom	W	W	Cement, sand and gravel, stone.
Whitman	580	248	Stone.
Yakima	W	W	Sand and gravel, stone, lime.
Undistributed[1]	148,088	122,469	
Total[2]	187,222	216,124	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes coal and some sand and gravel and stone that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Washington business activity

	1976	1977^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	1,586.0	1,640.0	+3.4
Unemployment do	137.0	144.0	+5.1
Employment (nonagricultural):			
Mining do	2.1	2.1	--
Manufacturing do	247.4	261.4	+5.7
Contract construction do	67.0	74.8	+11.6
Transportation and public utilities do	75.4	77.6	+2.9
Wholesale and retail trade do	306.8	328.0	+6.9
Finance, insurance, real estate do	68.2	74.8	+9.7
Services do	231.4	247.0	+6.7
Government do	273.1	277.7	+1.7
Total nonagricultural employment do	1,271.4	1,343.4	+5.7
Personal income:			
Total millions	$24,837	$27,534	+10.9
Per capita	$6,878	$7,528	+9.4
Construction activity:			
Number of private and public residential units authorized	47,883	61,771	+29.0
Value of nonresidential construction millions	$431.0	$532.4	+23.5
Value of state road contract awards do	$135.0	$205.0	+51.9
Shipments of portland and masonry cement to and within the State thousand short tons	1,177	1,365	+16.0
Mineral production value:			
Total crude mineral value millions	$187.2	$216.1	+15.4
Value per capita, resident population	$52	$59	+13.5
Value per square mile	$2,745	$3,169	+15.4

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

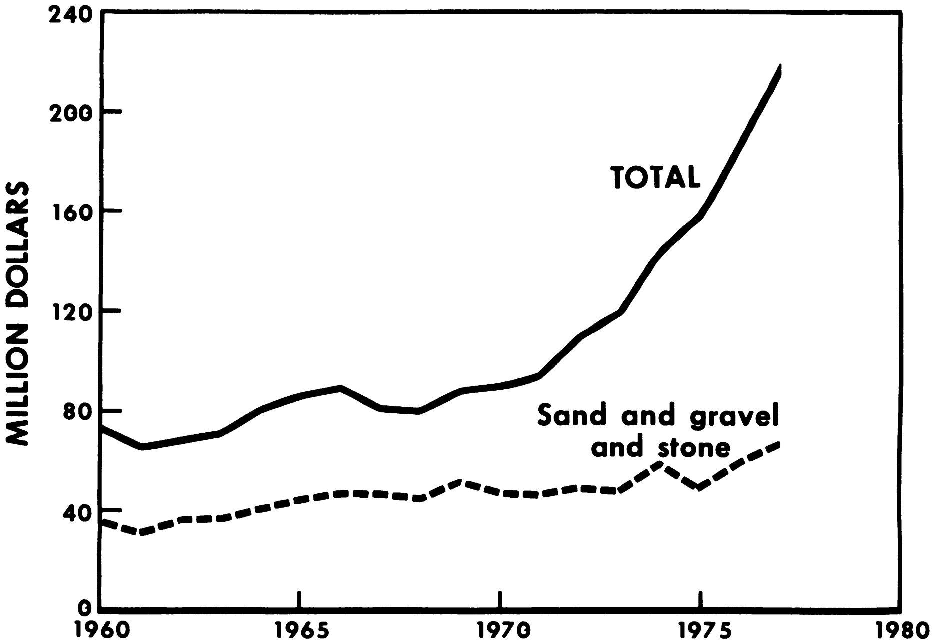

Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Washington.

Washington was not one of the Nation's major mineral-producing States in terms of production from local ores, but the total mineral industry, including processing, is a large contributor to the State's economy. Washington's seven aluminum-reduction plants produced 23% of the Nation's primary aluminum. The alumina used to produce aluminum came largely from Australia and Jamaica.

The ASARCO, Incorporated smelter and refinery in Tacoma produced 6.5% of the Nation's copper and also produced gold and silver. In addition, this smelter is the only plant in the United States that produces arsenic.

About 50 companies were active in mineral exploration during the year, reflecting a decrease of about 25% when compared with the number of companies that were active in exploration in 1976. Uranium exploration activity was near the 1976 level of activity, but base-metal activity for 1977 decreased.

Legislation and Government Programs.—No legislative actions were implemented during the year that affected the State's minerals industry.

The State of Washington has no severance tax or special tax that applies solely to mineral production. The Business and Occupation Tax applies to mineral extraction, which includes the production of mineral commodities and primary metals. Mineral production is taxed at the rate of 0.4664% of the gross value; the tax rate for primary aluminum production is 0.424%; and the rate for nuclear fuel assemblies is 0.265%.

Environment.—Environmental regulations have created serious uncertainties in the State's mineral industry, particularly for ASARCO's copper smelter operations in Tacoma. Since the Federal Clean Air Act became law, ASARCO reportedly has spent $30 million to protect the environment at the Tacoma smelter.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Calcium Chloride.—Two companies produced calcium chloride in 1977. At Tacoma, Hooker Chemical Corp. produced solid calcium chloride and Reichhold Chemicals, produced liquid calcium chloride. Both companies also produced numerous other organic and inorganic compounds.

Cement.—Sales of portland cement totaled 1.5 million tons valued at $65 million in 1977, reflecting an increase of 18% in quantity and 34% in value over the previous year's figures. Portland cement was produced at four plants: One at Bellingham, one at Metaline Falls, and two in Seattle.

Types of portland cement produced were types I and II (general use and moderate heat) gray and white, type III (high-early strength) gray, and type V (high-sulfur resistant).

Ready-mix concrete companies purchased 70% of the cement shipments; concrete product manufacturers purchased 13%; and other buyers purchased 17%. Home building and commercial construction sustained a high demand for cement during the year.

Columbia Cement Corp. (formerly Filtrol Corp.), Ideal Cement Co., and Lone Star Industries, Inc., have all switched to coal for power instead of gas or oil.

Clays.—Production of clays decreased 18% in quantity and 4% in value from the previous year's figure. Clay was produced in eight counties, although 90% was produced in Clallam, King, and Spokane Counties. Fire clay was produced only in King County.

Diatomite.—A new $8 million diatomaceous-earth processing plant was dedicated October 18, 1977, in Quincy, by officials of the Witco Chemical Corp. Raw material for the plant was mined from Witco's diatomite mine which consists of two open pits in the George area of Grant County, 19 miles from Quincy.

Gypsum.—Agro Minerals, Inc., continued mining at the Poison Lake mine in Okanogan County. Production was about 25% less than that of 1976. Kaiser Cement Gypsum Corp. calcined gypsum at its plant in Seattle; production increased 9% over that of last year.

Lime.—Lime was produced by the Utah-Idaho Sugar Co. in Grant and Yakima Counties and by Domtar Industries, Inc., in Pierce County. Production quantity declined from that of 1976, but total value remained unchanged. The lime produced was used for sugar refining, pulp and paper processing, calcium carbide production, sewage treatment, and other uses.

Peat.—Production of peat totaled 12,240 tons in 1977 valued at $117,218, reflecting a decrease of 13% in quantity but a 14% increase in value over the previous year's figures. Production was reported in five counties; the largest producing county was King County. Peat produced was sold for use in soil improvement.

Sand and Gravel.—Total production of sand and gravel decreased 7% in quantity but increased 9% in value compared with production quantity and value for 1976.

King County was the leading producing county during the year; it supplied 25% of the sand and gravel produced in the State, and was followed by Pierce County, which produced 16%. Construction sand and gravel accounted for 99% of the total sand and gravel produced; the remainder was industrial sand. Production came from 179 locations throughout the State. Construction sand and gravel was used for concrete aggregate and products (36%), roadbase and coverings (24%), asphaltic concrete (19%), fill (19%), and other uses (2%).

Table 4.—Washington: Sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	8,656	9,678	4,567	8,688
Gravel	10,954	24,885	13,789	29,006
Total[1]	19,610	34,562	18,356	37,693
Industrial sand	203	1,455	149	1,431
Grand total[1]	19,813	36,017	18,505	39,124

[1] Data may not add to totals shown because of independent rounding.

Table 5.—Washington: Construction sand and gravel sold or used by producers, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate	5,838	12,487	5,555	11,962
Concrete products	2,532	5,269	1,170	3,148
Asphaltic concrete	2,085	4,563	3,424	7,876
Roadbase and coverings	4,097	5,882	4,397	8,916
Fill	4,638	5,506	3,433	4,970
Railroad ballast	NA	NA	37	57
Other	419	856	340	765
Total[1]	19,610	34,562	18,356	37,693

NA Not available.
[1] Data may not add to totals shown because of independent rounding.

Stone.—Seven companies quarried dimension stone at seven quarries. The stone was used for rubble (54%), cut building stone (32%), rough flagging (11%), and other uses (3%). Output declined 13% from 1976 levels, to 4,529 tons valued at $440,000. Leading producers were Smith Limestone Co., Wilkeson Cut Stone Co., and Kifers Mica Slate Quarry. Crushed stone was produced by 86 companies at 244 quarries and was used for roadstone, surface-treatment aggregate, riprap, and other uses. Output increased 20% over 1976 output, to 12.2 million tons valued at $28.2 million. Leading noncommercial producers were the U.S. Forest Service, Washington State Highway Department, and the U.S. Bureau of Reclamation.

Among the 50 States, Washington ranked second in output of dimension traprock, and fourth in production of other crushed stone.

Table 6.—Washington: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Roadstone	2,100	4,892	3,939	8,210
Surface-treatment aggregate	2,191	5,305	1,936	4,525
Riprap and jetty stone	1,689	3,306	1,779	3,850
Bituminous aggregate	780	1,935	1,280	3,359
Dense-graded roadbase stone	1,285	2,397	943	1,644
Cement manufacture	W	W	800	1,336
Fill	224	240	378	445
Macadam aggregate	123	323	300	522
Railroad ballast	W	W	295	583
Concrete aggregate	210	540	W	W
Glass manufacture	W	W	W	1,037
Asphalt filler	41	173	--	--
Ferrosilicon	35	W	37	W
Terrazzo and exposed aggregate	W	W	33	846
Agricultural limestone	17	192	15	170
Mineral food	--	--	8	91
Roofing granules	W	W	W	17
Drain fields	3	8	2	W
Flux stone	W	W	W	3
Other uses[2]	1,518	4,304	492	1,516
Total[3]	10,218	23,614	12,239	28,156

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes traprock, granite, limestone, sandstone, miscellaneous stone, and marble.

[2] Includes stone used in magnesium metal, abrasives, paper manufacturing (1976), lime manufacturing (1977), refractory stone (1977), uses not specified (1976), and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Sulfur.—Three companies recovered sulfur, sulfur dioxide (SO_2), or hydrogen sulfide (H_2S). Atlantic Richfield Co. produced sulfur in Whatcom County, Shell Oil Co. produced hydrogen sulfide in Skagit County, and ASARCO produced liquid SO_2 in Pierce County.

METALS

Aluminum.—Washington ranked first in the Nation in quantity and value of primary aluminum produced in 1977, with 1 million short tons valued at $1 billion. Production quantity declined 10% from that of the previous year, but value increased 4%. Washington produced 23% of all primary aluminum produced in the United States. Output came from five companies and seven plants; they produced aluminum primarily from alumina imported from Australia and Jamaica. The average U.S. ingot price was 51.6 cents per pound.

Energy cutbacks caused layoffs at Washington aluminum plants. All five operating aluminum producers laid off workers, and consequently, production was cut by an average of 12%. Bonneville Power Administration (BPA) reduced the industry's power by 25% late in 1976, but companies were able to purchase or borrow power from other sources. The northwest aluminum industry used about 25% of BPA's power in 1977.

Table 7.—Washington: Primary aluminum plant production data

Year	Primary production			Average U.S. ingot price per pound (cents)
	Quantity (thousand short tons)	Percent of national total	Value (thousands)	
1972	1,049	25	$532,678	26.3
1973	1,048	23	513,732	25.3
1974	1,178	24	713,175	34.1
1975	1,075	28	847,908	39.8
1976	1,150	27	1,021,662	44.6
1977	1,032	23	1,064,799	51.6

Kaiser Aluminum & Chemical Corp. announced that a $45 million production expansion project will take place over the next 2 years at its Trentwood rolling mill. Production of aluminum sheet and plate is planned to be increased by 20%. This expansion is planned as the first phase of a larger investment to increase output by as much as 50%. Capacity of the plant now is about 400 million pounds annually.

Copper.—Mine production of copper dropped to less than half that produced during the previous year. The reason for the decline is discussed in the lead-zinc section of this chapter.

The $7 million program at ASARCO's Tacoma copper smelter to improve the capture of solid-particle emissions proceeded on schedule. ASARCO spent about $2 million on this program in 1977. The principal purpose of the project was to filter gasses from the copper ore roasting furnaces.[3]

The Lone Star pit was developed north of the Valley mine near Danville, in Ferry County by the Lone Star Mining Co., in conjunction with Granby Mining Corp. of Grennwood, British Columbia. Ore from this pit grades about 1% copper with over 610,000 tons of minable reserves. Molybdenum occurs sporadically in the altered quartz-monzonite host rock as blebs and stringers.

Copper and molybdenum investigations were predominant in the Cascade Range, particularly in King and Snohomish Counties. In Snohomish County, near Darrington, Duval Corp. drilled a copper property at Gold Hill, and Inspiration Development Co. drilled in the vicinity of Helena Peak. The Sultan Basin, north of Sultan, was the center of much exploration activity. Two copper-molybdenum properties were drilled in south-central Snohomish County by Occidental Minerals Corp. and Cities Service Minerals Corp.

In King County, northeast of North Bend, Duval prospected for copper in the Mount Si area, and Houston Oil and Minerals Corp. drilled at the Middle Fork copper property.

Cities Service investigated base metals in the Carbon River area northwest of Mount Rainier. In northern Skamania County, Duval continued development work on a low-grade copper property in the St. Helens District. In southern Skamania County, Amoco Minerals Co. explored a copper breccia—the Miners Queen property in the Silver Star Mountain area.

In the northern Cascade Mountains of western Okanogan County, Quintana Minerals Corp. explored its Mazama copper property northwest of Winthrop. In central Okanogan County, Gulf Mineral Resources Co. drilled for copper in the Omak area. Near the Canadian border, in northeastern Okanogan County, Dresser Industries, Inc. was drilling the Buckhorn Mountain holdings of Sunshine Valley Minerals for copper-molybdenum.

In northern Ferry County, Inspiration Development prospected for copper on Togo and Marble Mountains.

In Stevens County, Noranda continued to drill in quartz monzonite for copper and molybdenum, northeast of Kettle Falls in the Pingsten-Gold Creek area.[4]

Gold-Silver.—Production of gold — at 24,006 troy ounces — was down from that of 1976, but value increased in 1977 to $3.6 million. Production of silver totaled 120,582 troy ounces valued at $557,090. Both quantity and value decreased from the previous year's levels.

After 40 years of production, the Knob Hill gold mine north of Republic in Ferry County closed due to dwindling ore supplies. Only a few miles away, however, Ruby Mines, Inc., mined ore from the Valley gold mine on the west side of Curlew Lake and shipped the ore to its mill in Omak.

In scattered areas of the central and eastern Cascade Range, several gold and silver occurrences were under investigation by U.S. and Canadian companies. East of Mount Rainier in western Yakima County, Teck Corp. explored the potential of a low-grade gold-silver deposit in the Morse Creek area of the Summit mining district. Near Wenatchee, in southern Chelan County, Cyprus Mines Corp. continued development at the Gold King gold mine. In the western part of the county, east of Glacier Peak, Texasgulf, Inc. examined the gold-silver-copper deposit of the old Royal-Red Mountain mine.

In the Harts Pass region of the northern Cascades, Lion's Mines, Ltd., undertook exploratory trenching at the Newlite gold mine. Southeast of this area, near Twisp in Okanogan County, Continental Mining and Excavating Inc. undertook limited exploration at the Alder gold mine, where the company foresees the possibility of a massive sulfide deposit within an ore zone extension. Limited silver exploration continued in central Okanogan County in the Conconully and Oroville areas.

In the Republic area of Ferry County,

exploration was carried out at the Flag Hill gold mine by Houston Oil and Minerals Corp. for the second year. Northwest of Republic, near the Okanogan-Ferry County border, Occidental Minerals Corp. explored for silver in the Sheridan District. In this same region, Kittie Glide Mines, Ltd., of Vancouver prospected heavily for tungsten, silver, and gold on its properties in the Horseshoe Mountain-Kelly Mountain area. Twenty holes were drilled and numerous geological, geochemical, and geophysical surveys were undertaken.

The Melrose silver mine, located in northeastern Stevens County near the Canadian border and operated by Charleston Resources, intensified exploration and development this year with open pit mining operations. In the Chewelah area of central Stevens County, silver exploration was carried out by the Chewelah Silver Group.[5]

Lead-Zinc.—Production of lead decreased in both quantity and value, from 1976 levels. Likewise, zinc production decreased. The reason for the decline in production was that early in May, workers at the Pend Oreille mine and concentrator and the Bunker Hill refining plant went on strike. All production was either halted or severely curtailed during the 4 1/2-month strike. In addition, a serious oversupply in world zinc markets caused zinc prices to weaken.

The strike was settled in September, and Bunker Hill then began the lengthy process of starting up its plants and mines. However, because of the depressed zinc market, the zinc plant operated at only 70% of capacity, and mine production of zinc ore was cut proportionately. Ore reserves at the Pend Oreille mine were reported to have totaled 110,000 tons at yearend.[6] The Pend Oreille mine was the major lead-zinc mine in Washington, but closed indefinitely in September.

Slumping metal prices and over-supplied markets also left Washington with a low level of exploration activity for lead and zinc in 1977.

In northeastern Stevens County, Brinex, Ltd., examined possible ore extensions at the Van Stone mine. The mine is currently owned by Callahan Mining Co., U.S. Borax, and Brinex. Brinex explored the lead-zinc occurrence at the Iroquois property near the Canadian border. Near Northport, the Boggs Bros. Construction Co. engaged in limited development of the Phillips Ranch lead-zinc mine.

In the northern Cascade Range, Valumines, Inc., reportedly drilled a lead-zinc-silver-copper occurrence in Skagit County, southwest of Mount Logan.[7]

Magnesium.—Northwest Alloys, Inc., located near Addy, is a subsidiary of the Aluminum Company of America and a producer of magnesium. Northwest Alloys operates a plant rated at 24,000 tons for the production of magnesium metal from dolomite, and silicon metal from quartzite mined near the plant. Northwest initially invested about $100 million in the plant. This included $20 million that was spent for pollution control equipment.

Tungsten.—During 1977, there was minor production of tungsten ore from Stevens County. Production was from the Blue Grouse mine near Deer Lake.

Uranium.—The most intense exploration for a metal during the year was for uranium. The greatest concentration of exploration occurred in the Pend Oreille Valley in Pend Oreille County and in southwest Stevens County.

Dawn Mining Co., which operates the Midnite mine, milled 158,000 short tons of uranium ore graded at 0.11% U_3O_8 during the year.[8] The Midnite mine is the State's only producing uranium mine.

Dawn Mining also carried out an extensive exploration program. Diamond drilling adjacent to the present open pit area developed about 100,000 tons of additional ore, resulting in proven reserves of 631,000 tons graded at 0.13% U_3O_8 and an additional 130,000 tons of ore averaging 0.29% U_3O_8. All uranium exploration on properties held by Midnite Mines, Inc., was carried out by Dawn Mining.[9]

The Midnite Mines open pit operation is located on the Spokane Indian Reservation. Outside the area of the Midnite mine is a total of 36,000 acres yet to be explored for more reserves.

Scores of other companies have probed the Spokane Indian Reservation, which is said to contain 4% of the Nation's uranium reserves.

Western Nuclear, Inc., a wholly owned subsidiary of Phelps Dodge Corp., developed an open pit mine and started construction of a 2,000-ton-per-day uranium mill. The Sherwood project, located on the Spokane Indian Reservation in Stevens County, was scheduled to be in full operation by mid-1978.

MINERAL FUELS

Washington Irrigation and Development Co. is the major coal producer in the State. Its coal production is used exclusively at the 1,400-megawatt coal-fired generating plant located near Centralia in Lewis County. This coal is produced by strip mining, and all the disturbed land is being reclaimed and returned to the most productive agricultural use possible.

Gulf Oil Corp. proposed to the U.S. Department of Energy (DOE) that DOE participate in the development of a $400-million-plus, 6,000-ton-per-day demonstration plant for Gulf's Solvent Refined Coal liquefaction process. The technology was proven during 1977 in a Government-funded pilot plant operated by Pittsburg and Midway Coal Mining Co. at Fort Lewis. The company produced a liquid boiler fuel that is environmentally acceptable. Unfortunately, this fuel is more costly at current prices than imported distillates.[10]

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[1] State Liaison Officer, Bureau of Mines, Olympia, Wash.

[2] Liaison program assistant, Bureau of Mines, Olympia, Wash.

[3] ASARCO, Inc. 1977 Annual Report, p. 6.

[4] Milne, C. Metallic Mineral Exploration in Washington, 1977. Washington Geologic Newsletter, v. 6, No. 1, January 1978, 14 pp.

[5] Page 7 of work cited in footnote 4.

[6] Gulf Resources & Chemical Corp. 1977 Annual Report, pp. 8, 9.

[7] Page 5 of work cited in footnote 4.

[8] Newmont Mining Corp. 1977 Annual Report, p. 11.

[9] Midnite Mines, Inc. 1977 Annual Report, p. 6.

[10] Gulf Oil Corp. 1977 Annual Report, p. 19.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
NONMETALS			
Cement:			
Columbia Cement Corp.[1]	Marietta Rd., Box 37 Bellingham, WA 98225	Plant	Whatcom.
Ideal Basic Industries, Inc.[1,2]	420 Ideal Cement Bldg. Denver, CO 80202	do	King.
Lehigh Portland Cement Co.[1]	718 Hamilton St. Allentown, PA 18105	do	Pend Oreille.
Lone Star Industries, Inc.[3]	One Greenwich Plaza Greenwich, CN 06830	do	King.
Clays:			
Interpace Corp	2901 Los Feliz Blvd. Los Angeles, CA 90039	Pits and plants.	King, Spokane, Stevens.
Mutual Materials Co	Box 2009 Bellevue, WA 98009	do	King and Pierce.
Diatomite:			
Witco Chemical Corp	277 Park Ave. New York, NY 10017	Mine and plant.	Grant.
Gypsum:			
Agro Minerals, Inc	Box 611 Tonasket, WA 98855	Plant	Okanogan.
Lime:			
Domtar Industries, Inc	1220 Alexander Ave. Tacoma, WA 98421	do	Pierce.
Utah-Idaho Sugar Co	Drawer 970 Moses Lake, WA 98837	do	Grant.
	Box 752 Toppenish, WA 98948	do	Yakima.
Olivine:			
Northwest International	329 Kincaid St. Mount Vernone, WA 98273	Mine and plant.	Skagit.
Peat:			
Cunningham Sand and Gravel Co., Inc	N. 8510 Crestline Spokane, WA 99208	Bog	Spokane.
Kildow Brothers, Inc	6400 Capitol Blvd. Tumwater, WA 98501	Bog	Thurston.
Maple Valley Humus	18805 SE 170th St. Renton, WA 98055	Bog	King.
Plant Food Co	14515 35th Ave. Bothell, WA 98011	Bog	Snohomish.
Pumice:			
D. M. Layman, Inc	Box 1324 Goldendale, WA 98620	Mine and plant.	Klickitat.
Sand and gravel:			
Associated Sand & Gravel Co., Inc	Box 2037 Everett, WA 98203	Pit and plant	Snohomish.
Cadman Gravel Co	18816 Union Hill Rd. Redmond, WA 98052	do	King.
Friday Harbor Sand and Gravel Co	Box 1203 Bellingham, WA 98225	do	San Juan.
Lakeside Sand and Gravel Co., Inc	Box 46 Issaquah, WA 98027	do	King.
Lane Mountain Silica, Inc.[4]	Box 236 Valley, WA 99181	do	Stevens.
Miles Sand and Gravel Co	Box 130 Auburn, WA 98002	Pits and plant	King.
Silicon carbide:			
The Carborundum Co	Box 291 Vancouver, WA 98660	Plant	Clark.
Stone:			
Black River Quarry, Inc	6808 S. 140th St. Seattle, WA 98178	Quarries	King.
DeAtley Corp	Box 648 Lewiston, ID 83501	do	Asotin.
General Construction Co	Box 3845 Seattle, WA 98124	Quarry and plant.	Jefferson.
Pacific Quarries, Inc	1860 Hickox Rd. Mount Vernon, WA 98273	do	Skagit.
Pioneer Towing Co	Box 224 Kenmore, WA 98028	do	Kitsap.
Stoen Construction Co	Box 488 Monroe, WA 98272	Quarries	King and Snohomish.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
NONMETALS —Continued			
Stone —Continued			
Woodworth & Co., Inc	1200 East D St. Tacoma, WA 98421	Quarries	Pierce.
Sulfuric acid, smelter:			
ASARCO, Inc.[5]	Box 1605 Tacoma, WA 98401	Plant	Do.
Talc and soapstone:			
Skagit Talc Co	220 Reed St. Sedro Wooley, WA 98284	Quarry	Skagit.
Vermiculite (exfoliated):			
Vermiculite-Northwestern, Inc	Box A Auburn, WA 98002	Plant	Spokane.
METALS			
Aluminum:			
Aluminum Company of America	Box 120 Vancouver, WA 98660	do	Clark.
	Box 221 Wenatchee, WA 98801	do	Chelan.
Intalco Aluminum Corp	Box 937 Ferndale, WA 98248	do	Whatcom.
Kaiser Aluminum & Chemical Corp	Box 6217 Spokane, WA 99207	do	Spokane.
	8400 Taylor Way Tacoma, WA 98421	do	Pierce.
Martin Marietta Corp	Box 46 Goldendale, WA 98620	do	Klickitat.
Reynolds Metals Co	Box 999 Longview, WA 98632	do	Cowlitz.
Ferroalloys:			
Hanna Mining Co	Box 361 Wenatchee, WA 98801	do	Douglas.
Gold:			
Knob Hill Mines, Inc.[6]	Republic, WA 99166	Mine and mill	Ferry.
Lead-zinc:			
The Bunker Hill Co.[7] (Pend Oreille Mine)	Box 29 Kellogg, ID 83837	do	Pend Oreille.
Magnesium:			
Northwest Alloys, Inc	Box 115 Addy, WA 99101	Plant and mine.	Stevens.
Steel:			
Bethlehem Steel Co	Box 3827 Seattle, WA 98124	Plant	King.
Northwest Steel Rolling Mills, Inc	4315 9th Ave., N.W. Seattle, WA 98107	do	Do.
Uranium:			
Dawn Mining Co	Box 25 Ford, WA 99013	Mine and mill	Stevens.
MINERAL FUELS			
Coal:			
Washington Irrigation and Development Co.	1015 Big Hanaford Rd. Centralia, WA 98531	Strip mine	Lewis.

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[1] Also stone.
[2] Also clays.
[3] Also sand and gravel.
[4] Produces industrial sand.
[5] Also arsenic, copper, gold, and silver.
[6] Also silver, copper, lead and zinc.
[7] Also copper, gold, and silver.

The Mineral Industry of West Virginia

This chapter has been prepared under a memorandum of understanding between the Bureau of Mines, U.S. Department of the Interior, and the West Virginia Geological and Economic Survey.

By Grace N. Broderick[1] and Lois J. Litfin[2]

In 1977, the value of mineral production in West Virginia was $3.2 billion, a decrease of 8% from that of 1976. Coal accounted for almost $3 billion, or 92% of the value of all minerals produced. Although West Virginia continued to rank second to Kentucky in total U.S. production of bituminous coal, the coal output of the State dropped to the lowest level since 1938.

Table 1.—Mineral production in West Virginia[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	275	$463	389	$599
Coal (bituminous) do	108,834	3,278,180	95,433	2,961,186
Gem stones	NA	2	NA	2
Natural gas million cubic feet	153,322	87,394	152,767	93,188
Petroleum (crude) thousand 42-gallon barrels	2,519	30,227	2,518	35,175
Salt thousand short tons	1,118	W	1,048	W
Sand and gravel[3] do	4,337	11,006	3,891	10,402
Stone (crushed) do	9,717	24,133	10,495	28,022
Combined value of cement (masonry and portland), clays (fire), lime, natural gas liquids, sand and gravel (industrial), stone (dimension), and items indicated by symbol W	XX	66,596	XX	79,494
Total	XX	3,498,001	XX	3,208,068
Total 1967 constant dollars	XX	1,795,524	XX	[P]1,588,502

[P]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes fire clay; value included in "Combined value" figure.

[3] Excludes industrial sand and gravel; value included in "Combined value" figure.

Table 2.—Value of mineral production in West Virginia, by county[1]

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Barbour	NA	NA	
Berkeley	$20,181	$26,188	Cement, stone, lime, clays.
Boone	NA	210	Stone.
Braxton	4	2	Do.
Brooke	NA	NA	
Cabell	W	16	Clays.
Clay	NA	NA	
Fayette	220	W	Stone.
Gilmer	57	W	Do.
Grant	W	258	Do.
Greenbrier	W	W	Do.
Hampshire	W	W	Do.
Hancock	W	W	Sand and gravel, clays.
Harrison	413	603	Stone.
Jackson	--	W	Sand and gravel.
Jefferson	W	W	Stone.
Kanawha	W	W	Do.
Lewis	W	NA	
Lincoln	W	8	Clays.
Logan	W	NA	
McDowell	NA	NA	
Marion	NA	190	Stone.
Marshall	W	W	Salt.
Mason	W	44	Sand and gravel.
Mercer	W	W	Stone.
Mineral	W	W	Do.
Mingo	NA	NA	
Monongalia	W	W	Stone.
Monroe	4	1	Do.
Morgan	W	W	Sand and gravel.
Nicholas	W	--	
Ohio	NA	--	
Pendleton	W	W	Lime, stone.
Pocohontas	350	W	Stone.
Preston	W	W	Do.
Raleigh	1,049	1,271	Do.
Randolph	1,851	3,567	Do.
Roane	186	64	Do.
Summers	NA	--	
Taylor	NA	--	
Tucker	W	W	Stone.
Tyler	W	W	Salt, sand and gravel.
Upshur	NA	NA	
Wayne	W	NA	
Webster	NA	NA	
Wetzel	W	W	Sand and gravel.
Wirt	65	20	Stone.
Wood	W	--	
Wyoming	156	--	
Undistributed[2]	3,473,466	3,175,625	
Total[3]	3,498,001	3,208,068	

NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Calhoun, Doddridge, Hardy, Pleasants, Putnam, and Ritchie counties are not listed because no production was reported.

[2] Includes natural gas, natural gas liquids, petroleum, coal and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of West Virginia business activity

		1976	1977[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	683.0	693.0	+1.5
Unemployment	do	51.0	49.0	-3.9
Employment (nonagricultural):				
Mining	do	68.6	66.0	-3.8
Manufacturing	do	124.4	124.4	--
Contract construction	do	33.2	36.3	+9.3
Transportation and public utilities		39.6	40.4	+2.0
Wholesale and retail trade	do	117.8	121.6	+3.2
Finance, insurance, real estate	do	18.9	19.5	+3.2
Services	do	84.1	86.0	+2.3
Government	do	109.6	111.0	+1.3
Total nonagricultural employment	do	596.2	605.2	+1.5
Personal income:				
Total	millions	$10,033	$11,129	+10.9
Per capita		$5,476	$5,986	+9.3
Construction activity:				
Number of private and public residential units authorized		2,647	3,519	+32.9
Value of nonresidential construction	millions	$65.5	$72.0	+9.9
Value of State road contract awards	do	$261.0	$250.0	-4.2
Shipments of portland and masonry cement to and within the State	thousand short tons	630	632	+.3
Mineral production value:				
Total crude mineral value	millions	$3,498.0	$3,208.1	-8.3
Value per capita, resident population	do	$1,921	$1,726	-10.2
Value per square mile	do	$144,659	$132,669	-8.3

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

Trends and Developments.—Concern about declining coal production and productivity increased in West Virginia as labor-management relations remained unstable in 1977. A midsummer strike in protest of reductions in health and welfare benefits spread over a 10-week period from southern West Virginia to include most of the State's coal mines. On December 6, 1977, a national strike began, following expiration of the 1974 contract between the United Mine Workers of America and the Bituminous Coal Operators' Association.

Shortages of natural gas early in 1977 prompted a number of gas-consuming companies to initiate drilling programs to assure adequate energy supplies in the future. Kaiser Aluminum & Chemical Corp. started drilling wells and installing transmission pipelines in Jackson County to insure future natural gas supplies for its Ravenswood plant.

To comply with West Virginia's air-quality implementation plan administered by the Air Pollution Control Commission, Kaiser began retrofitting the dry-scrubbing system on its carbon-baking furnaces with a filter bag system. At hearings in September 1977, the company was granted a variance to bring the operation into compliance. The Commission negotiated with Sharon Steel Corp. to bring the coking unit at Fairmont into compliance. A 1975 compliance order involving emissions from Wheeling-Pittsburgh Steel Corp.'s coke batteries at the Follansbee plant was upheld in Brooke County Circuit Court; the State Supreme Court refused to consider the company's appeal.

Employment, Wages, and Injuries.—According to the West Virginia Department of Mines annual report, coal mining employment totaled 61,815 persons in 1977, when 52,532 persons were underground mine workers, and 9,283 were surface mine workers. Comparable coal mine employment for 1976 totaled 59,802 persons, 51,771 at underground mines and 8,031 at surface mines. According to the West Virginia Coal Association, average weekly wages for coal miners in 1977 were $307.83 in 1977, compared with $295.24 in 1976.

The number of miners certified by the West Virginia Department of Mines decreased 34.5%, from 6,691 in 1976 to 4,382 in 1977. The number of mine supervisor and/or fire boss certificates issued, however, increased 9.4%, from 1,212 in 1976 to 1,326 in 1977.

The number of fatal coal mine injuries declined from 32 in 1976 to 28 in 1977. The rate of coal mine fatalities continued to drop, with the 1977 ratio being 0.30 fatal accidents per million worker-hours, compared with 0.32 in 1976.

Legislation and Government Programs.—The first regular session of the 63rd Legislature passed a coal mine health and safety bill (Com. Sub. for S.B. 285) that transferred regulation development responsibility to a newly created Board of Coal Mine Health and Safety, required emergency medical technicians to be at mine sites, increased supervision of new miners, expanded electrical and communications requirements, changed penalties for operators who violate health or safety rules, required certification of surface mine supervisors, and extended qualifications for mine inspectors.

The legislature did not renew the State's 22-county strip mining moratorium that had existed since 1971. A bill (H.B. 1382) requiring a special surface mining permit when coal is removed incidental to commercial, residential, industrial or civic construction, however, included a new surface mining law that permits mining in all 55 counties only after certain requirements are met. The new law requires backfilling of mined areas to the approximate original contour and restricts placement of spoil downslope below mined areas on steep slopes. Requirements can be modified by the State to permit the mountaintop removal method of surface mining and the construction of valley fills.

The Federal Government enacted in 1977 laws dealing with mine health and safety and surface mining. The Federal Mine Safety and Health Amendments Act of 1977, Public Law 95-164, repealed the Federal Metal and Nonmetallic Mine Safety Act of 1966 and combined enforcement of metal and nonmetal mine regulations with regulation of coal mines under the Federal Coal Mine Health and Safety Act of 1969, Public Law 91-173. Responsibility for administering mine health and safety regulations was transferred from the U.S. Department of the Interior to the Mine Safety and Health Administration in the U.S. Department of Labor. Under the provisions of the new act, the National Mine Health and Safety Academy at Beckley, W. Va., and mine health and safety research remain as responsibilities of the Department of the Interior. In addition, the act provides minimum training standards for miners, new black lung benefit eligibility requirements, walkaround rights for miners to accompany mine inspectors, no discrimination by operators against miners bringing alleged violations to the attention of inspectors, and compensation for miners who are idled by mine closure orders issued for health or safety infractions.

The Federal Surface Mining Control and Reclamation Act of 1977, Public Law 95-87, set minimum mining environmental controls and reclamation standards for both surface and underground coal mines and authorized a study with recommendations for mining other commodities. The act provided for State administration of Federally approved enforcement programs with Federal overview; however, Federal enforcement of the standards would be required when a State enforcement program is not submitted for approval, when it is not approved, or when it fails. The act provides support for State coal research laboratories, for 2-year energy resource fellowships for master's level study or research, and for reclamation of abandoned coal-mined lands. Areas considered unsuitable for mining of commodities other than coal on Federally owned lands may be so designated after the resources in the area, the demand for the commodity, and the comparative impacts of developing the area or withdrawing it from entry are evaluated. Proposed initial performance standards authorized by the act were issued on December 13, 1977, and challenged almost immediately by civil suits filed in the U.S. District Court in Charleston by mining companies and the State of West Virginia.

Environmental studies of coal mining activity in the Gauley River Basin and portions of the Monongahela River Basin were being prepared by the Environmental Protection Agency to comply with provisions of the Federal Water Pollution Control Act. This act requires that issuance of water cleanup permits to new sources come under provisions of the National Environmental Policy Act. New mining operations in some areas could be approved immediately because significant environmental harm would not occur. Areas in which new mining activity would not be approved immediately would be subject to a more detailed environmental impact statement prior to the final permit issuance.

A field study of the mineral resources in the Cranberry Backcountry Wilderness Area was completed by the Federal Bureau of Mines and the Geological Survey. This 36,300-acre area in the Monongahela National Forest was designated by the Eastern Wilderness Act of 1975 for study to determine its suitability for a possible future addition to the National Wilderness Preservation System. A required mineral evaluation has been completed in the 10,215-acre Dolly Sods Wilderness Area, and a similar study was begun on the 20,000-acre Otter Creek Wilderness Area.

Two abandoned and 19 active sites in West Virginia were among those included in the General Accounting Office (GAO) report on the results of its interagency study of 42 coal waste disposal sites. The survey team was composed of members from the Corps of Engineers, Soil Conservation Service, West Virginia and Kentucky Departments of Natural Resources, Mining Enforcement and Safety Administration (MESA), and GAO. The team rated the disposal sites according to present condition and potential for causing loss of life or property under specific amounts of rainfall. The study stemmed from a Congressional request to determine the need for improvements in MESA's coal mine waste disposal program.

The U.S. Forest Service neared completion of its evaluation of roadless areas in the Monongahela National Forest to select candidate sites for inclusion in the wilderness system. Selection of these Roadless Area Review and Evaluation (RARE II) areas involved local input into the land management planning process. The input was provided through public review and critique of the draft environmental impact statement during 1978, before the final impact statement is published in early 1979. Twenty-two sites with a total area of 228,672 acres, including 219,340 acres of public land within the Monongahela National Forest, have been proposed under the RARE II program. Of the surface acreage in public ownership, the mineral rights on 106,000 acres are privately owned. The gross acreage within the Monongahela National Forest proclamation area totals 1,673,590, but only 842,869 of these acres are publicly owned and administered by the Forest Service.

Also influencing future land-use decisions in the State were the results of the Corps of Engineers water resource studies in the Gauley and Kanawha River basins. During the initial series of planning studies, five multiple-purpose water resource project areas were considered that included five pumped-storage hydroelectric generating sites, three conventional hydroelectric generating sites, and one local flood protection site. All but four pumped-storage hydroelectric generating sites were recommended for further study.

The first abandoned-mine-subsidence-control project using fly ash injection in West Virginia was initiated at Fairmont by the Federal Bureau of Mines. The $1.5 million project includes injection of 300,000 tons of fly ash in a slurry through cased boreholes to protect nearly $9 million in surface real estate.

Coalbed methane drainage projects, conducted cooperatively by the Federal Bureau of Mines and coal companies in Raleigh, Marion, and Monongalia Counties hold promise for reducing gas explosion hazards to underground miners and for increasing supplies for natural gas consumers. Methane drainage projects were conducted in the Pittsburgh coalbed at mines operated by Consolidation Coal Co. and Eastern Associated Coal Corp., and in the Beckley coalbed at mines operated by Beckley Coal Mining Co. and New River Co. These projects indicate the feasibility of methane removal under favorable geologic conditions with further refinements in drainage techniques.

The West Virginia Geological and Economic Survey completed an extensive compilation of data on the economic potential of limestones in West Virginia. A report of the results, including mineralogical and chemical analyses of samples from both operating mines and unexploited outcrops, was open filed and will be periodically expanded as more samples are obtained and analyzed.

A uranium-reconnaissance study in the Dunkard Basin of western West Virginia, conducted by the West Virginia Geological and Economic Survey, involved a stratigraphic, petrographic, and geochemical analysis of outcrop fluvial and distributary channel sandstones. Three radioactive anomalies were delineated in outcrops along U.S. Route 50 in Ritchie and Wood Counties. Analyses of samples from these outcrops by the U.S. Energy Research and Development Administration indicated the uranium content was very small, ranging from 37 to 46 parts per million U_3O_8.

Research grants for coal and other energy-related research projects at West Virginia University, Morgantown, totaled $9.3 million during 1977. Federal Government grants totaled $7.9 million, the State provided $750,857, and private groups supplied $590,876. Research areas included automated underground mine environmental-monitoring systems, design of safer mine power systems, control of mine strata, development of uses for coal-fired-powerplant waste, solution of mining environmental problems, and utilization of coal resources.

Mine training programs at colleges in the State continued to expand to fulfill the increasing demands for trained technicians, engineers, managers, and miners. A new 2-year mining management program was initiated at Alderson-Broaddus College at Philippi. Expanded mining technology courses were announced at the Wheeling and New Martinsville campuses of the West Virginia Northern Community College. The mining technology curriculum of Bluefield State College, Bluefield, was increased from a 2-year to a 4-year program.

The West Virginia Department of Natural Resources (DNR) began inspecting more than 200 non-Federal dams in the State to identify potentially hazardous sites. The $1.5 million effort by DNR's Coal Refuse and Dam Control section is part of a national dam inspection program being conducted by the Corps of Engineers. Mine and preparation plant impoundments and fly ash ponds, as well as freshwater dams, were inspected to locate possible structural weaknesses, inadequate overflow capacities, and other deficiencies.

The West Virginia Department of Mines conducted a maximum effort to reduce mine roof fall hazards. To prevent exposing miners to roof falls as much as possible, State mine inspectors were assigned to concentrate on a section-by-section inspection of every active underground mine for hazardous roof conditions. After the extensive inspections, training in proper development of roof control plans and adherence thereto by all underground mine employees were considered integral parts of this critical program.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Black.—Carbon black, used mostly by the rubber industry and in the manufacture of ink, was produced at two furnace process plants, one each in Marshall and Pleasants Counties. The production of carbon black increased nearly 14% over that of 1976. The total value of the production increased 24% over the 1976 value.

Coal (Bituminous).—Production of bituminous coal in West Virginia in 1977 amounted to 95.4 million short tons, compared with 108.8 million short tons in 1976. Only Monongalia County, the State's leading coal-producing county since 1974, produced more than 10 million tons in 1977. Strikes, severe winter weather, and further eroding of the State's metallurgical coal market were all factors contributing to the declining production, which was the lowest output reported since 1938.

Table 4.—West Virginia: Bituminous coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1973	115,448	1,340,338
1974	102,462	2,218,418
1975	109,283	3,206,951
1976	108,834	3,278,180
1977	95,433	2,961,186

Coke and Coal Chemicals.—Coke produced at three oven-coke plants totaled 3.2 million tons. Coal carbonized at these coke plants amounted to 4.7 million tons. The coke yield was 66.93%, slightly higher than the 1976 yield of 66.8%. The average value per ton of coal used at West Virginia coking plants in 1977 was $45.25, compared with $43.93 in 1976. A total of 4.5 million tons of coal was received by these plants in 1977, with 2.1 million tons from Pennsylvania, 1.8 million tons from West Virginia, and 0.6 million tons from Kentucky and Virginia. Coal-chemical materials produced at these oven-coke plants included tar, gas, ammonium sulfate, and crude light oil.

Natural Gas Liquids.—Natural gas liquids continued to be produced by Columbia Gas Transmission Corp. at its Cobb plant in Kanawha County, its Kenova plant in

Wayne County, and by Consolidated Gas Supply Corp. at its Hastings plant in Wetzel County. Compared with 1976, production remained about the same in quantity, but increased nearly 20% in value.

Petroleum and Natural Gas.—Crude oil production in 1977 was 2,518,000 barrels valued at $35,175,000, compared with 2,519,000 barrels valued at $30,227,000 in 1976. Natural gas production decreased slightly from 153,322 million cubic feet in 1976 to 152,767 million cubic feet in 1977, but rose in value from $87.4 million to $93.2 million.

The Oil and Gas Division of the West Virginia Department of Mines issued 1,624 permits to drill new wells or deepen old wells during 1977, an increase of 38.5% over 1,173 permits issued in 1976. The total number of wells completed, including 64 workovers, was 1,279, an increase of 24.5% over total well completions in 1976. Of these 1,279 wells, 880 were gas wells, 90 were oil, 77 were combination, 65 were miscellaneous (44 injection wells, 16 gas storage wells, 3 brine production, and 2 gasification tests), and 167 were dry. The Ashland-Clark Gap field in McDowell and Mercer Counties was the most active gasfield, and the Griffithsville field in Lincoln County was the most active oilfield.

Completed exploratory wells totaled 112, including 26 new-field wildcats, 9 of which were successful; 10 new-pool tests, 5 of which were discoveries; 48 deeper pool tests, 17 of which were deeper pool discoveries; 6 shallow-pool tests, 5 of which were discoveries; and 32 outpost wells. Exploratory programs concentrated on the lower Chemung and Brallier sandstones in north-central West Virginia, and on Pocono and Greenbrier tests in central and southern counties.

West Virginia has 25 gas storage fields, several of which have multiple-storage reservoirs. A total of 313,175 million cubic feet of gas was stored in these fields at the beginning of 1977, which ranked West Virginia sixth in the United States in storage gas.

NONMETALS

Cement.—Production of portland cement increased 17.7% over the 1976 level; shipments and the total value of those shipments increased 13.8% and 18%, respectively. The average value per ton increased above the 1976 level by 4%. Stocks on hand at the end of 1977 declined 60.1%, compared with those on hand at the end of 1976.

Trucks transported 84.8% of the 1977 portland cement shipments, and railroads carried the balance of 15.2%. The pattern of distribution of these shipments was 56.0% to ready-mix concrete companies, 28.5% to concrete product manufacturers, 6.2% to building material dealers, 0.4% to highway contractors, and 8.9% to unspecified contractors and government agencies.

Masonry cement production increased 11.6% during 1977, and the amount sold increased 16.4% over the amount in 1976. The total value of shipments increased 18.8%, with the average value per ton increasing about 2.0%. Stocks on hand at the end of the year were 23.0% below the level of stocks on hand at the end of 1976.

Both portland and masonry cement were produced by Martin Marietta Corp., the only producer of cement in the State. The company operated three coal-fired kilns, located near Martinsburg in Berkeley County.

Clays.—Berkeley, Cabell, Hancock, and Lincoln Counties produced clays in 1977. Berkeley County was again the leading producer of miscellaneous clay, and Hancock County continued to be the sole producer of fire clay. Total production of all clays increased 18.7% over that of 1976, and the total value of production increased 6.2%. Miscellaneous clay production increased more than 41%, and the total value of this production was up 29%. Production of fire clay decreased nearly 4%, but its total value increased 4%. Miscellaneous clays were mostly used in the manufacture of cement and building brick. Fire clays were used chiefly for producing firebrick and block.

Iron Oxide Pigments.—Chemetron Corp. continued to manufacture iron oxides at its plant in Huntington, and National Steel Corp. produced regenerator iron oxide at its plant at Weirton. Mobay Chemical Corp. announced plans to add a $50 million iron oxide pigment plant at its New Martinsville factory. The first stage of the new iron oxide facility, a 30-million-pound-per-year plant, was scheduled for 1978. Ultimately, the new plant is to have a production capacity of 91 million pounds per year, which would make it the largest single iron oxide plant in the United States.

Lime.—Production of lime was reported from two operations, with quicklime produced in Berkeley County and both quicklime and hydrated lime being produced in

Pendleton County.

Salt.—Production, reported from Marshall and Tyler Counties, declined more than 6% from that of 1976; value, however, rose more than 5%. Allied Chemical Corp. and PPG Industries, Inc., in Marshall County, and FMC Corp. at Bens Run near the Tyler-Pleasants County line, produced brines from deepwell solution mining. Both Allied Chemical and PPG used the brine to make chlorine and caustic substances on their Marshall County sites, but FMC shipped its brine down the Ohio and Kanawha Rivers to the FMC plant at South Charleston in Kanawha County.

Sand and Gravel.—Output of sand and gravel in 1977, excluding industrial sand and gravel, amounted to 3.9 million short tons valued at $10.4 million. Six companies with eight operations produced in six counties during 1977. The leading producers, in descending order of production, were Hancock, Morgan, and Tyler Counties.

Table 5.—West Virginia: Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Processed:				
Sand	2,056	5,062	2,017	5,401
Gravel	2,280	5,943	1,874	5,001
Industrial sand	W	W	W	W
Total[1]	4,337	11,006	3,891	10,402

W Withheld to avoid disclosing company proprietary data.
[1] Data may not add to totals shown because of independent rounding.

Table 6.—West Virginia: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	2,391	5,407	1,587	4,996
Concrete products (cement blocks, bricks, pipe, etc.)	1,121	3,522	1,462	3,760
Asphaltic concrete aggregates and other bituminous mixtures	501	1,049	89	342
Roadbase and covering	91	47	169	253
Fill	108	231	367	537
Other uses	124	749	217	514
Total[1]	4,337	11,006	3,891	10,402

[1] Data may not add to totals shown because of independent rounding.

Stone.—Howard W. Fields Co. quarried a small quantity of dimension sandstone in Greenbrier County for rough flagging. Crushed stone was produced by 44 companies at 55 quarries for roadstone, roadbase aggregate, cement, and other uses. Output increased 8% to 10.5 million tons valued at $28 million. Leading producers were Greer Steel Co., Martin-Marietta Corp., and Acme Limestone Co.

Table 7.—West Virginia: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction aggregate and roadstone	2,722	7,257	2,311	6,552
Dense-graded roadbase stone	1,636	4,653	2,207	6,598
Concrete aggregate	1,172	2,670	1,525	4,145
Railroad ballast	574	951	592	1,137
Surface treatment aggregate	542	1,163	554	1,416
Bituminous aggregate	297	819	304	901
Mine dusting	168	1,266	173	1,415
Agricultural limestone	157	475	126	487
Riprap and jetty stone	29	96	39	130
Fill	12	42	W	W
Macadam aggregate	17	46	9	27
Other uses[2]	2,391	4,710	2,656	5,214
Total[3]	9,717	24,133	10,495	28,022

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone and sandstone.

[2] Includes stone used in cement manufacture, flux stone, lime manufacture, abrasives (1977), soil conditioners, refractory stone, filter stone, sulfur dioxide (1977), disinfectant, other uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

METALS

Aluminum.—The Kaiser Aluminum & Chemical Corp. plant at Ravenswood, Jackson County, continued to be the sole producer of primary aluminum in West Virginia. Total production increased 43.2%; total value increased 65.7% over the 1976 levels.

Ferroalloys.—The total production of all types of ferroalloys was 145,474 short tons. Compared with 1976 production, 1977 production decreased 23,946 short tons, or 14.1%. The total value of this production was $87.7 million, an increase of 7% over the 1976 value. These ferroalloys were produced by the Union Carbide Corp. at its Alloy plant in Fayette County, Foote Mineral Co. at its Graham plant in Mason County, and Diamond Shamrock Corp. at its Kingwood plant in Preston County.

Iron and Steel.—Production of pig iron during 1977 declined 8.3%; shipments declined 8.1%. Stocks on hand at yearend were 44.1% below the yearend stock level in 1976. The total value of shipments decreased 8.0%.

The Weirton Steel Div. of National Steel Corp. reported that the continuous caster set a monthly tonnage record in November 1977, and that during 1977 more steel was cast than in any year since the facility began production in 1968. New pouring techniques and control devices scheduled to go into production early in 1978 were expected to increase the caster's productivity further.

Nickel.—High-nickel alloys were fabricated by the Huntington Alloy Products Div. of the International Nickel Co., Inc., at its Huntington plant in Cabell County.

Zinc.—The zinc plant at Spelter in Harrison County, which is operated by Meadowbrook Corp., a wholly owned subsidiary of TL Diamond and Co., Inc., produced zinc dust and slab zinc in 1977. Raw materials used were zinc drosses, zinc ashes, and other zinc residues.

Zirconium and Hafnium.—AMAX, Inc., sold its metal plant in Wood County to the L. B. Foster Co., a pipe manufacturer.

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[1] State Liaison Officer, Bureau of Mines, Charleston, W. Va.

[2] Program assistant, Bureau of Mines Liaison Office, Charleston, W. Va.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon black:			
Cabot Corp	125 High St. Boston, MA 02110	Furnace	Pleasants.
Cities Service Co	Box 300 Tulsa, OK 74102	do	Marshall.
Cement:			
Martin-Marietta Corp.[1]	277 Park Ave. New York, NY 10017	Plant	Berkeley.
Clays:			
Continental Clay Products Co	Box 1111 Martinsburg, WV 25401	Pit	Do.
Crescent Brick Co., Inc	Box 368 New Cumberland, WV 26047	Underground mine	Hancock.
Globe Refractories, Inc	Box D Newell, WV 24060	do	Do.
Coal:			
Armco Steel Co	703 Curtis St. Middletown, OH 45042	Underground mines	Boone and Raleigh.
Bethlehem Mines Corp	Martin Tower Bethlehem, PA 18016	Underground and strip mines.	Barbour, Boone, Kanawha, Marion, Nicholas, Raleigh, Upshur.
Consolidation Coal Co	1 Oliver Plaza Pittsburgh, PA 15222	Underground, strip, and auger mines.	Harrison, McDowell, Marion, Marshall, Mercer, Monongalia, Raleigh, Wyoming.
Eastern Associated Coal Corp	Koppers Bldg. Pittsburgh, PA 15219	Underground and strip mines.	Boone, McDowell, Marion, Monongalia, Raleigh, Wyoming.
Island Creek Coal Co	2355 Harrodsburg Rd. Lexington, KY 40511	do	Boone, Grant, Greenbrier, Logan, Nicholas, Preston, Upshur, Wyoming.
United States Steel Corp	600 Grant St. Pittsburgh, PA 15230	do	McDowell, Mingo, Wyoming.
Valley Camp Coal Co	700 Westgate Tower Cleveland, OH 44116	do	Kanawha, Marshall, Ohio.
Westmoreland Coal Co	123 South Broad St. Philadelphia, PA 19109	do	Boone, Fayette, Greenbrier, Logan, Nicholas, Raleigh, Upshur, Wyoming.
Iron oxide pigments, finished:			
Chemetron Corp	491 Columbia Ave. Holland, MI 49423	Plant	Cabell.
National Steel Corp	Weirton Steel Div. Weirton, WV 26062	do	Hancock.
Lime:			
Greer Limestone Co	Greer Bldg. Morgantown, WV 26505	do	Pendleton.
Riverton Corp	Riverton, VA 22651	do	Berkeley.
Natural gas liquids:			
Columbia Gas Transmission Corp	1700 MacCorkle Ave., SE. Charleston, WV 25314	Plants	Kanawha and Wayne.
Consolidated Gas Supply Corp	445 West Main St. Clarksburg, WV 26301	Plant	Wetzel.
Petroleum refineries:			
Pennzoil Co	Oil City, PA 16301	do	Kanawha.
Quaker State Oil Refining Corp	Farmers Valley, PA 16749	Plants	Hancock and Pleasants.

See footnote at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Salt:			
Allied Chemical Corp	Box 1219R Morristown, NJ 07960	Brine wells and plant	Marshall.
FMC Corp	Box 8127 South Charleston, WV 25303	do	Tyler.
PPG Industries, Inc	1 Gateway Center Pittsburgh, PA 15222	do	Marshall.
Sand and gravel:			
Dravo Corp	1 Oliver Plaza Pittsburgh, PA 15222	Dredge	Hancock.
McDonough Co	Box 538 Parkersburg, WV 26100	do	Tyler and Wetzel.
Pennsylvania Glass Sand Corp	Berkeley Springs, WV 25411	Plant	Morgan.
Shippingport Sand and Gravel Co	1200 Stambough Bldg. Youngstown, OH 44501	do	Hancock.
Smelters:			
Kaiser Aluminum & Chemical Corp.	300 Lakeside Dr. Oakland, CA 94626	do	Jackson.
Stone:			
Acme Limestone Co	Box 27 Fort Spring, WV 24936	Mine and quarry	Greenbrier.
Elkins Limestone Co	Box 1228 Elkins, WV 26241	do	Randolph.
The H. Frazier Co., Inc	Box 1877 Richmond, VA 23211	Quarry	Greenbrier.
Greer Steel Co	Greer Bldg. Morgantown, WV 26505	Mine and quarries	Monongalia and Pendleton.
Martin-Marietta Corp	277 Park Ave. New York, NY 10017	Quarry	Berkeley.
Shenandoah Quarry, Inc	Box C Millville, WV 25432	do	Jefferson.
United States Steel Corp	600 Grant St. Pittsburgh, PA 15230	do	Do.

[1] Also clays.

The Mineral Industry of Wisconsin

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Geological and Natural History Survey of Wisconsin, under a Memorandum of Understanding for collecting information on all minerals except coal and liquid fuels.

By John L. Reuss,[1] Patricia LaTour,[2] and Thomas J. Evans[3]

The overall output from Wisconsin mineral operations in 1977 was not significantly different from that of 1976, but the total value of mineral production increased approximately 13% to a record high of $150.1 million. This situation reflected a period of increasing prices and costs as inflationary economic pressures caused unit prices of most minerals to escalate.

Nonmetallic minerals, particularly sand and gravel and crushed stone produced for use as construction aggregate, continued to dominate State mineral totals for both quantity and value. Nonmetallic minerals accounted for 81% of the total mineral value during 1977. Although most of the nonmetallic minerals registered a slight to moderate increase in product output and value, a significant decrease in cement production offset these gains and served to hold the collective totals at the 1976 level.

Iron ore mining continued to be the most important metallic mining industry in the State. Production of taconite pellets during 1977 stabilized, with the output nearly equal to that of the previous year. Eagle-Picher Industries, Inc., operated two mines in the Upper Mississippi Valley district and produced zinc and lead concentrates at a slightly higher rate than that established during 1976. However, a continual erosion of zinc metal prices during 1977 resulted in a decline in product value.

The recent discoveries of three significant copper and zinc deposits have generated an accelerating interest in mineral exploration

Table 1.—Mineral production in Wisconsin[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	$1	NA	$1
Iron ore (usable) thousand long tons, gross weight	664	W	668	W
Lime thousand short tons	325	10,058	378	13,521
Peat do.	11	W	14	196
Sand and gravel do.	30,879	42,001	29,025	50,210
Stone do.	20,739	41,338	22,314	46,918
Combined value of abrasive stone, cement, clays, lead, zinc, and values indicated by symbol W	XX	39,055	XX	39,282
Total	XX	132,453	XX	150,128
Total 1967 constant dollars	XX	67,988	XX	[p]74,103

[p] Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in Wisconsin, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Adams	$29	$74	Sand and gravel.
Ashland	43	78	Do.
Barron	1,048	1,334	Do.
Bayfield	W	W	Do.
Brown	W	W	Lime, stone, sand and gravel.
Buffalo	789	782	Stone, sand and gravel.
Burnett	331	745	Sand and gravel, stone.
Calumet	W	W	Stone, sand and gravel.
Chippewa	496	1,042	Sand and gravel.
Clark	1,538	656	Sand and gravel, stone.
Columbia	W	W	Do.
Crawford	837	W	Do.
Dane	W	4,376	Do.
Dodge	W	W	Lime, stone, sand and gravel.
Door	574	1,036	Sand and gravel, stone.
Douglas	13,151	W	Lime, cement, sand and gravel, stone.
Dunn	595	W	Stone, sand and gravel.
Eau Claire	W	1,271	Sand and gravel.
Florence	29	29	Do.
Fond du Lac	2,134	W	Stone, sand and gravel, lime, clays.
Forest	W	79	Sand and gravel.
Grant	W	W	Stone, sand and gravel.
Green	W	W	Do.
Green Lake	1,938	1,530	Sand and gravel, stone.
Iowa	693	645	Stone.
Iron	111	W	Sand and gravel.
Jackson	W	W	Iron ore, sand and gravel.
Jefferson	432	358	Sand and gravel, stone.
Juneau	W	W	Stone, sand and gravel.
Kenosha	1,526	1,280	Sand and gravel.
Kewaunee	444	538	Do.
La Crosse	W	W	Stone, sand and gravel.
Lafayette	W	W	Zinc, stone, lead.
Langlade	W	W	Sand and gravel.
Lincoln	601	317	Sand and gravel, peat.
Manitowoc	4,704	7,212	Cement, lime, sand and gravel, stone.
Marathon	5,368	6,755	Stone, sand and gravel.
Marinette	2,430	2,353	Do.
Marquette	W	W	Do.
Menominee	W	--	
Milwaukee	W	W	Cement, stone.
Monroe	239	935	Stone.
Oconto	W	1,010	Sand and gravel, stone.
Oneida	698	728	Sand and gravel.
Outagamie	W	W	Stone, sand and gravel.
Ozaukee	W	W	Sand and gravel, stone.
Pepin	W	W	Stone, sand and gravel.
Pierce	W	W	Do.
Polk	2,401	3,394	Do.
Portage	765	1,408	Sand and gravel.
Price	32	102	Do.
Racine	2,605	2,659	Stone, sand and gravel.
Richland	W	W	Do.
Rock	3,120	2,222	Sand and gravel, stone.
Rusk	462	3,254	Sand and gravel.
St. Croix	1,000	731	Stone, sand and gravel.
Sauk	W	W	Stone, sand and gravel, abrasive stone.
Sawyer	232	314	Sand and gravel.
Shawano	W	W	Sand and gravel, stone.
Sheboygan	W	1,174	Do.
Taylor	961	1,230	Sand and gravel.
Trempealeau	W	W	Stone.
Vernon	W	W	Do.
Vilas	389	515	Sand and gravel.
Walworth	921	778	Sand and gravel, stone.
Washburn	W	W	Sand and gravel.
Washington	W	W	Sand and gravel, stone.
Waukesha	W	12,733	Sand and gravel, stone, peat.
Waupaca	726	1,050	Sand and gravel, stone.
Waushara	426	W	Sand and gravel.
Winnebago	3,484	3,943	Stone, sand and gravel.
Wood	W	W	Do.
Undistributed[1]	74,149	79,453	
Total[2]	132,453	150,128	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes gem stones and some sand and gravel which cannot be assigned to specific counties and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Wisconsin business activity

		1976	1977^p	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,175.0	2,217.0	+1.9
Unemployment	do	122.0	109.0	-10.7
Employment (nonagricultural):				
Mining	do	2.5	2.4	-4.0
Manufacturing	do	519.1	533.1	+2.7
Contract construction	do	64.8	74.0	+14.2
Transportation and public utilities	do	82.3	84.5	+2.7
Wholesale and retail trade	do	387.2	404.7	+4.5
Finance, insurance, real estate	do	76.9	79.3	+3.1
Services	do	302.4	320.1	+5.9
Government	do	288.6	287.1	-.5
Total nonagricultural employment	do	1,723.8	1,785.2	+3.6
Personal income:				
Total	millions	$28,285	$32,047	+13.3
Per capita		$6,136	$6,890	+12.3
Construction activity:				
Number of private and public residential units authorized		35,263	41,296	+17.1
Value of nonresidential construction	millions	$394.7	$370.6	-6.1
Value of State road contract awards	do	$31.4	$30.0	-4.5
Shipments of portland and masonry cement to and within the State	thousand short tons	1,669	1,817	+8.9
Mineral production value:				
Total crude mineral value	millions	$132.5	$150.1	+13.3
Value per capita, resident population		$29	$32	+10.3
Value per square mile		$2,359	$2,675	+13.3

^{p}Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

and leasing throughout much of the northern half of the State. Although no new discoveries were announced during 1977, over 20 firms were actively engaged in mineral exploration programs. Activities at the discovery sites were concerned with premining planning, engineering, environment, and economic studies. This base-metal mineral activity also received recognition from concerned environmental and political groups.

A $70 million iron ore pellet transshipment terminal located on Allouez Bay in Douglas County began operations during June, and was formally dedicated on July 12. Operated by Burlington-Northern, Inc., the massive installation includes a loading berth to handle 1,000-foot vessels; nearly 4 miles of conveyors; an 87-acre, pellet-stockpiling area; and environmental protection equipment costing in excess of $1.5 million.

The Bay Shipbuilding Corp. at Sturgeon Bay completed construction of its first 1,000-foot supercarrier. The MV *Belle River* was christened on July 14 and after completing sea trials, began full-scale operations during August. The *Belle River* can carry 67,000 short tons of coal and can self-unload at a rate of 10,000 tons per hour. It has four diesel engines creating 14,000 shaft horsepower, a top speed of 16 mph, a beam measuring 105 feet, and an operating draft of 27.6 feet. A second 1,000-foot supercarrier was under construction and was scheduled for commissioning during the spring of 1978.

Legislation and Government Programs.—In anticipation of a significant increase in base-metal and other mining, considerable legislation was introduced into both houses of the Wisconsin Legislature. The following revisions and additions to the Wisconsin statutes represent some of the more significant environmental and mineral-related legislation that was considered by the State Legislature during 1977:

SB 111—Taxation of Metalliferous Minerals.—This bill would establish a net proceeds tax on metalliferous mining. It would repeal all prior taxes on metal mining in the State and create an Investment and Local Impact Fund Board to oversee the disbursement of tax revenues. The net proceeds tax would impose a graduated tax on the mining of metallic minerals, exempting the first $100,000 of annual net proceeds and taxing the balance with a progressive scale reaching a maximum of 20% on that part of the net proceeds which exceeds $30 million. This legislation was signed into law as Chapter 31, Laws of 1977, and became effective on July 7, 1977.

SB 568—Exploration Leases and Conveyances of Mineral Interests.—This legislation would reform the laws governing exploration leases and mineral conveyances. Exploration leases would not be valid until recorded with the Register of Deeds in the county and may be canceled within 10 days after they have been recorded by private individuals or within 90 days if the lessor is a public body. A maximum term of an exploration lease for metallic minerals would be 10 years, and any agreement for the purpose of developing or extracting minerals would have a maximum 50-year lease period under this law. Full disclosure of all parties with an economic interest and compensation, terms, and conditions of the agreement would be required. This bill was introduced on September 21, 1977. A public hearing was held on November 3, 1977, and it has been referred to the Senate Judiciary and Consumer Affairs Committee.

AB 865—Distribution of Revenues from Mining Tax.—This Bill relates to distribution of funds to counties and certain municipalities from the Investment and Local Impact Fund. It would allow the maximum guaranteed payment to counties to increase by the yearly rate of growth in the consumer price index after the distribution for the 1977 tax year. Action was completed on this legislation, and it was signed into law as Chapter 185, Laws of 1977, and became effective on November 29, 1977.

AB 1024—Solid and Hazardous Waste Disposal.—This bill, which was introduced on September 20, 1977, would establish a hazardous waste management program, which would include solid wastes. It would provide for fees collected from operations creating wastes to be put into a waste management fund from which money would be available for maintaining waste-disposal facilities on a long-term basis. Mine tailings would be included in disposal facilities requiring licensing pursuant to this bill. Another important aspect of this legislation would be the creation of a Metallic Mining Council, with broad public, environmental, and industry participation, to resolve issues and recommend definitive procedures to the Department of Natural Resources.

AB 1044—Regulation of Water Withdrawal for Purposes of Mining.—This legislation would provide for the regulation of water withdrawal for mining purposes and would modify existing laws which grant mining operations power to convey water over adjoining lands owned by others. This bill was introduced on October 26, 1977, and was recommended for passage by the Assembly Environmental Protection Committee on December 14, 1977.

AB 1045—Revision of the Metallic Mining Reclamation Act.—This Bill, which was introduced on October 26, 1977, would revise existing State statutes and mandate changes in the administrative code by the Department of Natural Resources (DNR) relating to reclamation of metal mines in Wisconsin. It would provide for environmental protection to be extended throughout the exploration, prospecting, and mining phases. On December 14, 1977, the Assembly Environmental Protection Committee recommended its passage.

Mineral rights registration and taxation issues will probably be the focus of legislative action in the future. A 1973 law created provisions for recording and taxing mineral rights. However, on November 14, 1977, the Supreme Court of Wisconsin upheld a lower court's decision declaring the law unconstitutional. The Supreme Court justified its ruling on the basis that enforcement provisions in the law denied "procedural and substantive due process." Subsequent attempts to provide for registration of mineral rights and taxation of mineral interests will be designed to accommodate the questions raised in the courts' decisions.

Nonmetallic mining in the State is being reviewed by the Mining Committee of the Joint Legislative Council, a legislative service agency. The Mining Committee is evaluating the regulations and reclamation procedures that apply to extraction of nonmetallic minerals. The council committee will submit a report and legislative proposals to the council for approval. If the committee's proposals are accepted and approved by the council, legislation will be introduced to carry out the recommendations.

The Wisconsin Geological and Natural History Survey published another report[4] in its continuing series of publications relating to mineral resources. In addition, a long-term mapping program was initiated in the Precambrian terrain in northern Wisconsin. This bedrock mapping project, at a scale of 1:250,000, has begun with the Iron Mountain sheet. The project is designed to generate basic geologic data on Precambrian units within the extensively drift-covered regions in northern Wisconsin. Other major geologic programs include (1) subsurface studies in eastern, southeastern, and southwestern Wisconsin to identify possible locations for underground storage of natural gas and (2) the continuing cataloging and analysis of well cuttings for high-capacity water wells from which detailed information on subsurface materials throughout the State is being collected.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Deburring and burnishing media were produced by Baraboo Quartzite Co., Inc., from a quartzite deposit near Baraboo in Sauk County. After quarrying, the quartzite is crushed, milled to remove sharp edges, and screened into uniform sizes. The company produces 15 sizes of abrasives, ranging in size from three-sixteenths by one-eighth inch to 1-3/4 by 1-1/4 inches. The material is consumed primarily by metal stamping plants and is usually sold in 100-pound bags. During 1977, both production and value of sales registered a moderate increase over that recorded during 1976.

Cement.—Shipments of portland and masonry cement from Wisconsin mills during 1977 were considerably below those of the previous year. This is the second consecutive year that the production of cement products has declined. The Medusa Cement Co. continued to operate its plant in Manitowoc County and produced Type III, waterproof, and other portland cements, in addition to masonry cement. Additionally, grinding facilities were operated by Universal Atlas Cement Div., United States Steel Corp. and Huron Cement Div., National Gypsum Co., at Milwaukee and Superior, respectively. Partially manufactured cement materials were shipped to these facilities from plants outside Wisconsin.

Cement produced in Wisconsin was used for everything from burial vaults to highway, building, and other construction projects. Most of the cement was distributed in bulk form by rail and truck to consumers within the State. Total cement consumed in Wisconsin was more than four times greater than the quantity produced within the State.

Clays.—The only producer of clays in the State during 1977 was the Oakfield Shale Brick & Tile Co. The company used all the clay and shale produced from its operation near Oakfield in Fond du Lac County in the manufacture of brick. Output from the operation during 1977 increased nearly 15% from the previous year.

Gem Stones.—Amateur mineral collectors and rockhounds collected semiprecious gem stones and mineral specimens, primarily from old mines, quarries, gravel pits, and mineral dumps. Value of the material found was estimated at $1,000.

Lime.—Three companies produced lime at five plants during 1977. The five plants, producing both quicklime and hydrated lime, were operated by The Western Lime & Cement Co., with plants in Brown, Dodge, and Fond du Lac Counties; the CLM Corp., with a plant in Douglas County; and the Rockwell Lime Co., with a plant in Manitowoc County. Expanded production facilities completed during 1976 contributed to a record output of over 378,000 short tons of lime. The combined value of lime production was over $13.5 million, a 34% increase from the comparable 1976 period. Table 4 shows quantity and value of lime used, by consuming industry.

Peat.—Prior to 1977, the U.S. Bureau of Mines classified peat as a fuel mineral. In mid-1977, to more closely aline peat with the Standard Industrial Classification groupings, and because peat has traditionally been used for other than fuel purposes in the United States, the Bureau of Mines began classifying it as a nonmetal.

The production of moss and humus peat from Wisconsin bogs increased approximately 31% to 13,854 tons during 1977. All of the peat and peat products were produced from bogs located in Waukesha or Lincoln Counties and were sold for horticultural purposes.

Perlite.—Crude perlite mined outside the State was expanded at two plants located in Appleton and Milwaukee. The expanded perlite was used primarily in plaster and concrete aggregate, with lesser amounts used for masonry and cavity fill insulation, horticultural aggregate, and other uses. Sales decreased 21% in quantity and 41% in value below that of 1976.

Sand and Gravel.—The Sand and gravel industry continued to rank as the largest mineral industry in Wisconsin. Production was 29 million tons, a slight decline from the previous year, but value of output increased approximately 20% to $50.2 million. Production of sand and gravel was reported from 312 operations located in 65 of the State's 72 counties.

Most of the sand and gravel was used within a short distance of the pit because low unit value and high transportation costs prohibit long distance shipments. Consequently, the greatest activity occurred near the large urban centers of southeastern Wisconsin (Dane, Manitowoc, Rock, Rusk, Waukesha, and Washington Counties). Production in excess of 1 million tons was reported from each of these counties and collectively they accounted for 36% of the State's output in 1977.

Table 4.—Wisconsin: Lime sold or used by producers, by use

Use	1976		1977	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Construction lime[1]	78,868	$2,698	93,646	$3,833
Water purification	W	W	66,296	2,227
Sewage treatment	47,170	1,467	W	W
Paint	1,395	41	W	W
Other uses	197,992	5,853	218,416	
Total[2]	325,438	10,058	378,358	13,521

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes soil stabilization, mason's lime, finishing lime, and other construction uses.

[2] Data may not add to totals shown because of independent rounding.

Table 5.—Wisconsin: Sand and gravel sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Construction:				
Sand	10,901	10,009	9,296	15,194
Gravel	18,730	25,739	18,863	29,982
Total[1]	29,630	35,750	28,159	45,176
Industrial sand	1,249	6,251	866	5,034
Grand total	30,879	42,001	29,025	50,210

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Wisconsin: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	8,319	12,155	7,371	14,447
Concrete products (cement blocks, bricks, pipe, etc.)	1,886	3,038	703	1,279
Asphaltic concrete aggregates and other bituminous mixtures	5,204	6,278	4,555	7,589
Roadbase and coverings	9,707	10,907	11,002	16,675
Fill	4,145	2,950	3,798	4,383
Other uses	370	420	730	803
Total[1]	29,630	35,750	28,159	45,176

[1] Data may not add to totals shown because of independent rounding.

Table 7.—Wisconsin: Sand and gravel sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams	1	56	29	1	59	74
Ashland	1	41	43	1	57	78
Barron	12	1,763	1,048	9	848	1,334
Bayfield	2	W	W	2	W	W
Brown	6	621	752	4	201	288
Buffalo	1	27	11	1	11	11
Burnett	3	320	316	6	445	719
Calumet	3	93	93	2	W	W
Chippewa	8	422	496	9	749	1,042
Clark	5	874	1,538	3	412	654
Columbia	11	997	3,961	7	820	3,977
Crawford	3	157	390	2	W	W
Dane	21	1,477	1,779	23	1,422	2,275
Dodge	8	415	323	5	294	458
Door	11	498	506	9	479	841
Douglas	5	52	76	2	45	77
Dunn	3	198	271	3	W	W
Eau Claire	3	W	W	6	636	1,271
Florence	3	19	29	1	20	29
Fond du Lac	7	272	267	5	325	468
Forest	2	W	W	1	60	79
Grant	1	10	W	1	W	W
Green Lake	7	555	1,832	7	628	1,513
Iron	3	113	111	2	W	W
Jackson	4	141	276	2	177	330
Jefferson	8	250	287	6	126	192
Juneau	1	22	25	1	102	181
Kenosha	5	1,006	1,526	5	746	1,280
Kewaunee	7	425	444	4	347	538
Lincoln	9	469	601	3	169	317
Manitowoc	14	893	887	11	1,081	1,706
Marathon	8	473	764	4	366	621
Marinette	7	133	320	5	80	150
Marquette	2	W	W	2	W	28
Oconto	8	529	710	7	630	935
Oneida	9	453	698	6	454	728
Ozaukee	8	433	605	6	504	757
Pepin	2	20	7	1	27	27
Pierce	5	229	423	2	144	411
Polk	6	573	529	5	507	857
Portage	4	629	765	3	870	1,408
Price	1	29	32	2	51	102
Racine	9	664	658	7	534	778
Richland	2	52	70	1	66	91
Rock	10	1,536	2,607	7	1,177	1,593
Rusk	7	502	462	4	2,148	3,254
St. Croix	5	402	457	4	128	193
Sauk	10	320	661	8	W	W
Sawyer	3	129	232	3	165	314
Shawano	8	318	500	5	221	469
Sheboygan	8	1,065	1,605	6	733	1,155
Taylor	9	732	961	10	745	1,230
Vilas	6	220	389	4	289	515
Walworth	20	947	780	8	458	695
Washington	9	1,843	1,905	8	1,327	1,868
Waukesha	32	3,586	3,873	27	4,242	7,177
Waupaca	5	600	684	5	597	1,008
Waushara	4	330	426	3	W	W
Winnebago	10	436	1,034	4	397	905
Undistributed[1]	19	1,512	1,928	11	1,905	3,205
Total[2]	414	30,879	42,001	312	29,025	50,210

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes Green, La Crosse, Langlade, Menominee (1976), Outagamie, Vernon (1976), Washburn, and Wood Counties, and some sand and gravel that cannot be assigned to specific counties.

[2] Data may not add to totals shown because of independent rounding.

Stone.—Stone is the second leading mineral commodity in Wisconsin. The 1977 output of all kinds of stone was 22.3 million tons valued at $46.9 million, a moderate increase over that of 1976. Dimension and crushed stone were produced from sedimentary, igneous, and metamorphic rocks found in the State. Although crushed stone accounted for more than 99% of the total stone produced, dimension stone value accounted for more than 10% of the total stone value.

Dimension stone was quarried by 26 companies at 32 sites for rubble, house stone veneer, rough flagging, and other uses. Output increased 2% from that of 1976 to 73,141 tons valued at $4.82 million. Among all States, Wisconsin ranked second in the output of dimension limestone and fifth in total dimension stone. Leading producers of dimension limestone were Halquist Stone Co., Inc., in Waukesha County and Oakfield Stone Co. in Fond du Lac County.

Crushed stone, primarily for use as construction aggregate, was produced by 120 companies at 339 quarries in 43 of the State's 72 counties. Production registered an 8% increase over that of 1976 to 22.2 million tons valued at $42.1 million. More than 1 million tons of crushed stone was produced in Waukesha and Winnebago Counties.

Table 8.—Wisconsin: Dimension stone[1] sold or used by producers, by use

Use	1976			1977		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rubble	22,240	278	$328	23,140	289	$430
House stone veneer	18,330	229	792	20,820	260	1,005
Rough flagging	5,228	65	107	7,160	90	192
Irregular-shaped stone	8,676	108	188	5,689	71	140
Dressed construction	2,976	37	71	3,326	42	84
Rough monumental	4,044	26	456	3,017	19	383
Dressed monumental	3,285	37	2,326	2,961	32	2,252
Sawed stone	2,222	26	114	2,411	29	128
Cut stone	1,831	23	164	1,933	24	166
Rough blocks	2,078	26	26	W	W	W
Curbing	257	3	4	W	W	3
Other uses[2]	592	7	15	2,681	33	39
Total[3]	71,764	866	4,591	73,141	889	4,821

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes granite, limestone, and sandstone.

[2] Includes stone used as dressed flagging, other miscellaneous uses (1976), and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 9.—Wisconsin: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	7,329	11,130	6,498	10,050
Roadstone	3,584	5,989	5,842	9,915
Surface treatment aggregate	2,252	3,498	2,214	4,166
Concrete aggregate	1,265	2,112	1,500	2,785
Railroad ballast	1,060	2,415	1,305	3,170
Roofing granules	W	W	1,256	3,850
Agricultural limestone	1,275	3,001	1,229	3,200
Bituminous aggregate	1,355	2,334	1,208	2,211
Macadam aggregate	578	1,123	551	983
Riprap and jetty stone	156	477	192	738
Lime manufacture	134	369	W	W
Fill	69	90	87	137
Filter stone	24	W	77	142
Flux stone	W	W	15	24
Drain fields	W	11	--	--
Other uses[2]	1,585	4,196	268	727
Total[3]	20,667	36,747	22,241	42,097

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, sandstone, granite, traprock, and miscellaneous stone.

[2] Includes stone used in abrasives, bedding material (1976), other miscellaneous uses, and uses indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

Table 10.—Wisconsin: Stone sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Kind of stone	1976 Number of quarries	1976 Quantity	1976 Value	1977 Number of quarries	1977 Quantity	1977 Value
Granite:						
Dimension	6	7	2,820	5	6	2,654
Crushed and broken	8	886	1,193	10	1,384	1,839
Total[1]	14	893	4,014	15	1,390	4,493
Limestone and dolomite:						
Dimension	25	64	1,750	25	67	2,164
Crushed and broken	339	17,705	29,768	321	18,160	32,718
Total[1]	356	17,768	31,518	338	18,227	34,883
Other stone:[2]						
Dimension	4	1	21	2	W	W
Crushed and broken	8	2,077	5,785	9	2,698	7,540
Total[1]	12	2,078	5,806	11	2,698	7,542
Total stone:						
Dimension	35	72	4,591	32	73	4,821
Crushed and broken	355	20,667	36,747	339	22,241	42,097
Grand total[1]	382	20,739	41,338	363	22,314	46,918

W Withheld to avoid disclosing company proprietary data; included with "Other stone."

[1] Data may not add to totals shown because of independent rounding.

[2] Includes quartzite, sandstone, traprock, other miscellaneous stone, and kinds of stone indicated by symbol W.

Table 11.—Wisconsin: Crushed limestone sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1976 Number of quarries	1976 Quantity	1976 Value	1977 Number of quarries	1977 Quantity	1977 Value
Brown	13	903	1,404	10	847	1,435
Buffalo	11	418	778	9	366	771
Calumet	9	394	510	7	312	427
Crawford	14	300	447	10	208	237
Dane	24	1,021	1,698	27	W	W
Dodge	11	686	1,172	9	680	1,203
Door	5	51	68	8	148	195
Dunn	6	147	324	5	180	378
Fond du Lac	14	671	958	10	696	1,267
Grant	22	714	1,162	21	665	1,268
Green	18	407	540	18	W	W
Green Lake	4	76	106	1	9	17
Iowa	15	489	693	16	495	645
Jefferson	4	86	145	3	90	166
La Crosse	5	723	994	7	661	973
Lafayette	15	521	714	20	425	588
Manitowoc	2	W	W	3	433	944
Marquette	1	48	W	1	106	W
Monroe	9	180	239	7	512	935
Oconto	4	W	W	3	51	75
Outagamie	6	657	1,076	5	557	917
Ozaukee	1	99	W	1	W	W
Pepin	4	179	W	5	237	W
Pierce	7	301	W	11	321	W
Polk	1	46	129	1	W	117
Racine	4	872	1,947	3	877	1,881
Richland	11	W	W	8	119	W
Rock	18	338	513	14	323	629
St. Croix	7	239	543	7	268	538
Sauk	7	W	W	7	133	W
Sheboygan	1	W	W	1	4	19
Trempealeau	8	334	W	10	312	W
Vernon	16	414	726	14	372	W
Walworth	1	W	141	1	W	83
Waukesha	10	2,157	3,664	12	2,546	4,380
Waupaca	1	26	42	1	26	42

See footnotes at end of table.

Table 11.—Wisconsin: Crushed limestone sold or used by producers, by county —Continued

(Thousand short tons and thousand dollars)

County	1976			1977		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Winnebago	15	1,433	2,450	14	1,397	3,038
Undistributed[1]	15	2,776	6,582	11	3,782	9,550
Total[2]	339	17,705	29,768	321	18,160	32,718

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1] Includes Columbia, Douglas (1976), Juneau, Marinette, Milwaukee, Shawano, and Washington Counties, and items indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Sulfur (Recovered Elemental).—Murphy Oil Corp. produced approximately 1,500 long tons of sulfur from a sulfur extraction plant at its Superior refinery in Douglas County. All of the recovered sulfur was shipped by railroad tankcar to a consumer in central Minnesota.

Vermiculite.—Crude vermiculite shipped into the State was exfoliated by Construction Products Div. of W. R. Grace & Co. in Milwaukee County and by Koos, Inc., in Kenosha County. The exfoliated material was used for loose fill and block insulation, fertilizer, horticulture, concrete aggregate, plaster aggregate, and fireproofing. In response to a strengthening demand for loose fill insulation, production increased by 50% from that of 1976, and overall value more than doubled.

METALS

Copper.—During the past several years, base-metal exploration in northern Wisconsin has been at a very high level. The sharp increase has resulted from the announced discoveries of three copper and zinc deposits and the relationship of rock types in Wisconsin to similar rocks in Canada containing known metal deposits. Although no new mines have been developed, Wisconsin has the potential to become a major metal-producing State.

Flambeau Mining Corp., a wholly owned subsidiary of Kennecott Copper Corp., announced its discovery of a copper deposit near Ladysmith, Rusk County, in the late 1960's. Surface drilling indicated a deposit of 4 to 6 million tons averaging about 4% copper. The Department of Natural Resources approved the Environmental Impact Statement regarding mining this property, but terminated the permit approval hearings as a result of local zoning denials related to financial concerns. Kennecott is continuing to monitor the environmental aspects at its property but is reluctant to move ahead in obtaining permits in the face of extremely low copper prices.

During 1975, Noranda Exploration Co. notified the State of its intent to develop an open pit copper-zinc mine near Rhinelander. The firm, a wholly owned subsidiary of Noranda Mines Ltd., of Toronto, Canada, discovered the deposit while drilling on lands owned by Consolidated Papers, Inc., in Oneida County. Noranda estimated the size of its discovery to be approximately 2.2 million tons, averaging about 4.5% zinc and nearly 1% copper. As a result of declining base-metal prices, the firm has delayed its intention to mine.

In 1976, Exxon—USA announced the discovery of a major zinc-copper deposit near Crandon. Present drilling indicates that the deposit contains about 70 million tons of mineralized material, averaging about 5% zinc and 1% copper. This deposit could rank as one of the top five massive sulfide deposits discovered in North America. Exxon is continuing further engineering work and economic studies but has not reached a final decision regarding mining. Even with a favorable decision to proceed with mining, permit approval procedures for prospecting and mining would make production prior to 1985 unlikely.

Iron Ore.—The Jackson County Iron Co., a wholly owned subsidiary of Inland Steel Co., was the only iron ore producer in the State during 1977. Production of taconite pellets from the firm's mine and processing facilities near Black River Falls in Jackson County was 668,000 long tons, nearly equal to the 1976 output. Total value, reflecting the benefits from a 5% escalation in the price of iron ore pellets, registered a slight increase. All pellets were shipped by rail to the parent company's Indiana Harbor Works at East Chicago, Ind.

During June, Burlington-Northern, Inc., began operations at its $70 million iron ore pellet transshipment terminal located on Allouez Bay in Douglas County. The complex, which is designed to handle iron ore pellets from Minnesota's expanding taconite operations, includes a 5-million-ton stockpile facility, more than 4 miles of conveyors, and a dockside shiploader with a 72,000-ton storage capacity. The dock is designed to accommodate lake carriers of up to 1,000 feet in length.

Zinc and Lead.—Eagle-Picher Industries, Inc., continued to operate its Shullsburg mill with ore supplied from the Shullsburg and Bear Hole mines in Lafayette County. Production of zinc and lead concentrates increased slightly, but product value, reflecting a reduced demand for zinc, suffered a slight decline from the previous year. During May, Eagle-Picher announced that it was abandoning its plans to reopen the Elmo mine in Grant County and the Crawhall mine in Lafayette County. Reopening of these two mines, which were expected to provide approximately 1,400 tons of crude ore daily, had been the subject of controversy because of the zinc content of the mine discharge water. All lead and zinc concentrates were shipped by rail to smelters outside the State.

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[1] State Liaison Officer, Bureau of Mines, Madison, Wis.

[2] Liaison program assistant, Bureau of Mines, Madison, Wis.

[3] Assistant professor, Minerals Information, Geological and Natural History Survey, Madison, Wis.

[4] May, E. R. Flambeau - A Precambrian Supergene Enriched Massive Sulfide. Geoscience Wisconsin, v. 1, 1977, 44 pp.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Baraboo Quartzite Co., Inc	Box 123 Baraboo, WI 53913	Quarry and plant	Sauk.
Cement:			
Medusa Cement Co., a division of Medusa Corp.	Box 5668 Cleveland, OH 44101	Dry process plant	Manitowoc.
National Gypsum Co., Huron Cement Div.	17515 West 9 Mile Rd. Southfield, MI 48075	Grinding plant only	Douglas.
United States Steel Corp. Universal Atlas Cement Div.	600 Grant St. Pittsburgh, PA 15230	do	Milwaukee.
Clay and shale:			
Oakfield Shale Brick & Tile Co	Box 337 Oakfield, WI 53065	Pit and plant	Fond du Lac.
Iron ore:			
Jackson County Iron Co.,a subsidiary of Inland Steel Co., Black River Falls.	30 West Monroe St. Chicago, IL 60603	Mine, concentrator, agglomerator.	Jackson.
Iron-oxide pigments, finished:			
DCS Color & Supply Co	1050 East Bay St. Milwaukee, WI 53217	Plant	Milwaukee.
Lime:			
CLM Corp	12th Ave. West & Waterfront Duluth, MN 55802	Quicklime and hydrated lime plants.	Douglas.
Rockwell Lime Co	Route 2, Box 124 Manitowoc, WI 54220	do	Manitowoc.
The Western Lime & Cement Co.:	Box 2076 Milwaukee, WI 53201		Do.
Green Bay plant		do	Brown.
Knowles plant		do	Dodge.
Eden plant		do	Fond du Lac.
Peat:			
Bogda's Top Soil & Excavating Co	12600 West Cleveland Ave. New Berlin, WI 53151	Bog and processing plant.	Waukesha.
Certified Peat & Sod, Inc	19000 West Lincoln Ave. New Berlin, WI 53151	do	Do.
Demilco, Inc., a division of Nitragin Sales Corp.	3101 West Custer Ave. Milwaukee, WI 53209	do	Do.
Perlite, expanded:			
W. R. Grace & Co., Construction Products Div.	62 Whittemore Ave. Cambridge, MA 02140	Processing plant	Milwaukee.
Midwest Perlite Co	542 West Linberg Appleton, WI 54911	do	Outagamie.
Sand and gravel:			
Construction sand and gravel:			
Genesee Aggregate Corp	10919 West Bluemond Rd. Milwaukee, WI 53226	Pit and plant	Waukesha.
Janesville Sand & Gravel Co	Box 427 Janesville, WI 53545	Pits and plants	Rock.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Construction sand and gravel —Continued			
Johnson Sand & Gravel, Inc	22750 Bluemond Rd. Waukesha, WI 53186	Pit and plant	Waukesha.
Edward Kraemer & Sons, Inc	Plain, WI 53577	Pits and plants	Barron, Chippewa, Eau Clair, Ozaukee.
McHenry Sand & Gravel Co., Inc	Box 511 McHenry, IL 60050	Pit and plant	Kenosha.
State Sand & Gravel Co	10833 West Watertown Plank Rd. Milwaukee, WI 53226	Pits and plants	Waukesha.
Tews Lime & Cement Co	6200 West Center St. Milwaukee, WI 53210	Pit and plant	Do.
Vulcan Materials Co., Midwest Div	Box 6 Countryside, IL 60525	do	Do.
Industrial sand:			
Chier Industrial Sand Co	Box 288 Berlin, WI 54923	do	Green Lake and Winnebago.
Martin Marietta Corp., Industrial Sand Div.	110 East Main St. Rockton, IL 61072	do	Columbia.
Stone:			
Granite:			
Anderson Bros. & Johnson Co	Box 26 Wausau, WI 54401	Quarries and plant	Marathon.
Ben Gottschalk, Inc	Route 1 Mosinee, WI 54455	do	Do.
Lake Wausau Granite Co	Box 397 Wausau, WI 54401	Quarry and plant	Do.
Limestone and dolomite:			
Courtney & Plummer, Inc	Box 767 Neenah, WI 54956	Quarries and plant	Calumet and Winnebago.
Daanen & Janssen	Box 127 De Pere, WI 54115	do	Brown.
Halquist Stone Co., Inc	N52 W23564 Lisbon Rd. Sussex, WI 53089	do	Waukesha.
Edward Kraemer & Sons, Inc	Plain, WI 53577	Quarries and plants	Buffalo, Crawford, Dunn, Juneau, La Crosse, Marquette, Pepin, Pierce, Richland, St. Croix, Sauk, Trempealeau, Vernon.
Landwehr Materials, Inc	Route 2 Appleton, WI 54911	Quarry and plant	Outagamie.
Madison Stone Co., Inc	5813 U.S. Highway 51 Madison, WI 53704	Quarries and plants	Dane.
Oakfield Stone Co	Box 221 Oakfield, WI 53065	Quarry and plants	Fond du Lac.
Arthur Overgaard Co	Box 87 Elroy, WI 53929	Quarries and plants	Buffalo, Juneau, La Crosse, Monroe.
Valders Lime & Stone Co	Box 35 Valders, WI 54245	Quarry and plant	Manitowoc.
Vulcan Materials Co., Midwest Div	Box 6 Countryside, IL 60525	Quarries and plants	Milwaukee, Racine, Waukesha, Winnebago.
G. A. Watson	Barneveld, WI 53507	do	Iowa and Lafayette.
Waukesha Lime & Stone Co	Route 5, Highway 164 Waukesha, WI 53186	Quarry and plants	Waukesha.
Wilbur Lime Products	544 East 6th St. Trempealeau, WI 54661	Quarries and plants	Buffalo, Pepin, Trempealeau.
Sandstone and quartzite:			
Foley Bros., Inc	Rock Springs, WI 53961	Quarry and plant	Sauk.
Minnesota Mining & Manufacturing Co	3M Center St. Paul, MN 55101	Quarries and plant	Marathon.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Traprock (basalt):			
Bryan Dresser Trap Rock, Inc	3750 Washington Ave. North Minneapolis, MN 55412	Quarry and plants	Polk.
GAF Corp	Box 630 Pembine, WI 54156	Quarry and plant	Marinette.
Sulfur, recovered elemental:			
Murphy Oil Corp	Box 2066 Superior, WI 54880	Byproduct sulfur recovery plant.	Douglas.
Vermiculite, exfoliated:			
W. R. Grace & Co., Construction Products Div.	62 Whittemore Ave. Cambridge, MA 02140	Processing plant	Milwaukee.
Koos, Inc	4500 13th Ct. Kenosha, WI 51340	do	Kenosha.
Zinc and lead:			
Eagle-Picher Industries, Inc.:	Box 406 Galena, IL 61036		
Bear Hole		Mine	Lafayette.
Shullsburg		Mine and mill	Do.

The Mineral Industry of Wyoming

By Charles A. Koch[1]

Wyoming's mineral production value, like its development, continued to increase to $2.3 billion in 1977, a 26% increase over that of 1976. The upward trend in value was the result of increased unit price of commodities. The value of the mineral production resulted in a national ranking of ninth for Wyoming. The principal mineral commodities according to value were crude petroleum, coal (bituminous), sodium carbonate, natural gas, and uranium. A combined value of these commodities was about $2.14 billion or 92% of the total value. The nonfossil fuel minerals accounted for 27% of the total mineral value.

Petroleum production in 1977 increased for the first time in 4 years. The coal production continues to set new records annually.

Uranium production increased by 1.8 million pounds, which is the second year the State's production has increased. This year's production is nearing the record production of 10 million pounds in 1973. Exploration and development work was very active in the State with one surface mine and two underground mines coming on-stream. The major portion of the activity was in the Powder River basin and the Gas Hills area. Wyoming continues to rank second in both production and reserves behind New Mexico.

The production of soda ash continues to increase as a result of plant expansions and the addition of a new mine in October of 1976. Texasgulf, Inc., near Granger, Wyo., is in its first full year of production. This is the first plant designed to use coal as a fuel source. Stauffer Chemical Co. of Wyoming is expanding its operation which will add about 300,000 tons to its yearly production and bring the plant capacity to 1.8 million tons.

Black Hills Bentonite completed installation of coal-firing equipment at its Worland and Casper plants. The company plans to use 80% coal and 20% natural gas. The 20% natural gas is to insure continuous combustion. The demand for Wyoming bentonite continues to increase, insuring producers of about a 10% increase in production.

Wyoming's increased production of coal from the Powder River Basin has resulted in the need for additional railroad track. As a result, Burlington Northern, Inc., is building a 116-mile line from Gillette to Orin. The new line will relieve traffic in the line from Gillette to Alliance, Nebr. This is the longest stretch of new track to be built in the United States since 1931.[2]

The State received over $63 million from the Federal Government in royalty, bonuses, and rentals during 1977. This has been the largest amount received from the Federal Government. The minerals that accounted for most of the value were oil, gas, and coal, but nearly all the minerals produced in the State had some production from Federal acreage.

U.S. Department of the Interior agencies were fairly active in Wyoming in 1977. The U.S. Geological Survey finished two environmental impact statements, a draft impact statement of the proposed East Gillette surface coal mine in northeastern Wyoming to be operated by Kerr-McGee Corp. and a final impact statement on the Eagle Butte surface mine to be operated by Amax Coal Co. The Survey was also doing fieldwork in the Powder River Basin on determination of coal reserves. The Federal Bureau of Mines has a grant with the Wyoming Geological

Survey to determine the coal reserves in the Hanna Basin. A site near Medicine Bow was chosen by the U.S. Bureau of Reclamation for a wind energy pilot project. A final report, "Corridor Study and Recommendations for Major Energy Related Transportation and Transmission Systems in the Eastern Powder River Basin Wyoming," was completed by the U.S. Bureau of Land Management during the year.

Wyoming's supply of energy minerals has resulted in a number of research projects by the Department of Energy (DOE) on coal and oil shale. DOE, through its Laramie Energy Research Center, is studying the potential of recovering a low-Btu gas by gasifying coal in place near Hanna. The process entails the drilling of vertical wells into the coal seam to provide for injection of air and collection of gases. A process of reverse combustion is used to link the wells followed by forward gasification of the coal. Lawrence Livermore Laboratory has a contract with DOE for research on a medium-Btu gas project at Hoe Creek. This process uses chemical explosives to fracture the coal and create permeability. Oxygen and steam are then used to produce medium-Btu gas. This project is still in the initial stage of operation. The Laramie Energy Research Center has been conducting research on in situ burning of oil shale to recover oil from the shale. These tests have been run at a site west of Rock Springs.

DOE signed a number of contracts and a cooperative agreement during the year. Gulf Research and Development Co. signed a $14.25 million cost-sharing contract to develop a process for gasification of otherwise inaccessible coal. A $12 million contract for development of a process to extract oil from shale in the Green River area was awarded to Talley-Frac Corp. of Mesa, Ariz. An agreement signed by the University of Wyoming's Rocky Mountain Institute of Energy and Environment and DOE's Laramie Energy Research Center will give the University nearly $1 million for research work on in-place conversion of coal, oil shale, and tar sands.

The Wyoming legislature concentrated on mineral taxation during its 1977 session. Two bills were passed to add a percentage tax on certain minerals. House Bill 187 levies an additional severance tax of 2% on uranium and 3% on coal. A mineral excise tax of 1.5% was levied on coal, uranium, and trona under House Bill 279. This excise tax expires on January 1 in the year following the collection of $250 million. A last-minute effort to get a 2-cent-per-gallon gasoline tax was defeated, but this lost revenue was recovered by imposing a 1% highway tax on the coal industry.

A Laramie County District Court upheld Wyoming's practice of assessing mineral severance taxes, including subsequent increases, upon the previous year's production. Belco Petroleum had challenged the July 1975 order by the State Board of Equilization. Companies had been paying under protest higher severance taxes adopted by the 1977 legislature on 1976 production.

Table 1.—Mineral production in Wyoming[1]

Mineral	1976		1977	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---- thousand short tons--	2,697	$40,015	2,966	$48,369
Coal (bituminous) ---- do----	30,836	215,936	46,028	377,990
Gem stones ----	NA	147	NA	200
Gypsum ---- thousand short tons--	317	1,280	356	2,571
Iron ore (usable) ---- thousand long tons, gross weight--	2,139	29,461	W	W
Natural gas ---- million cubic feet--	328,768	134,795	330,180	211,315
Natural gas liquids:				
Natural gasoline and cycle products ---- thousand 42-gallon barrels--	3,044	19,866	10,148	64,970
LP gases ---- do----	6,681	35,677		
Petroleum (crude) ---- do----	134,149	971,235	136,472	1,039,948
Sand and gravel ---- thousand short tons--	5,470	10,782	5,084	11,026
Stone ---- do----	2,757	7,630	[2]2,434	[2]7,585
Uranium (recoverable) ---- thousand pounds--	8,064	129,823	9,857	194,682

See footnotes at end of table.

Table 1.—Mineral production in Wyoming[1] —Continued

Mineral	1976 Quantity	1976 Value (thousands)	1977 Quantity	1977 Value (thousands)
Combined value of cement, feldspar, iron ore, lime, phosphate rock, sodium carbonate (natural), stone (dimension, 1977), and items indicated by symbol W	XX	$254,952	XX	$372,693
Total	XX	1,851,599	XX	2,331,349
Total 1967 constant dollars	XX	950,426	XX	[p]1,150,754

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes dimension stone; included with "Combined value" figure.

Table 2.—Value of mineral production in Wyoming, by county

(Thousands)

County	1976	1977	Minerals produced in 1977 in order of value
Albany	$11,220	$9,110	Cement, stone, clays, sand and gravel, gypsum.
Big Horn	42,572	18,451	Clays, gypsum, sand and gravel, lime.
Campbell	271,881	W	Sand and gravel.
Carbon	146,254	W	Uranium, sand and gravel.
Converse	131,591	W	Do.
Crook	39,144	W	Clays, stone, sand and gravel.
Fremont	173,488	126,878	Uranium, iron ore, sand and gravel, feldspar, stone.
Goshen	543	W	Lime, sand and gravel.
Hot Springs	80,399	--	
Johnson	32,483	W	Clays, sand and gravel, uranium.
Laramie	5,115	W	Stone, sand and gravel.
Lincoln	50,267	W	Phosphate rock, stone, sand and gravel.
Natrona	103,335	W	Uranium, sand and gravel, clays, stone.
Niobrara	4,021	--	
Park	201,054	W	Gypsum, sand and gravel.
Platte	13,440	W	Iron ore, stone, sand and gravel.
Sheridan	W	159	Sand and gravel.
Sublette	39,322	W	Stone, sand and gravel.
Sweetwater	354,429	W	Sodium carbonate, sand and gravel.
Teton	W	W	Sand and gravel, stone.
Uinta	714	W	Clays, stone, sand and gravel.
Washakie	21,200	W	Clays, lime, sand and gravel.
Weston	14,856	W	Clays, stone, sand and gravel.
Undistributed[1]	114,269	2,176,755	
Total[2]	1,851,599	2,331,349	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Includes petroleum, natural gas, natural gas liquids, and coal (bituminous) that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

[2]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Wyoming business activity

	1976	1977[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force thousands	179.0	193.0	+7.8
Unemployment do	7.0	7.0	--
Employment (nonagricultural):			
Mining do	20.7	24.9	+20.3
Manufacturing do	8.4	9.0	+7.1
Contract construction do	14.9	16.5	+10.7
Transportation and public utilities do	12.8	13.2	+3.1
Wholesale and retail trade do	35.1	37.4	+6.6
Finance, insurance, real estate do	5.1	5.5	+7.8
Services do	23.4	23.7	+1.3

See footnote at end of table.

Table 3.—Indicators of Wyoming business activity —Continued

	1976	1977[p]	Change, percent
Employment and labor force, annual average —Continued			
Employment (nonagricultural) —Continued			
Government thousands	36.1	37.3	+3.3
Total nonagricultural employment do.	156.5	167.5	+7.0
Personal income:			
Total millions	$2,642	$3,073	+16.3
Per capita	$6,764	$7,562	+11.8
Construction activity:			
Number of private and public residential units authorized	4,125	4,373	+6.0
Value of nonresidential construction millions	$38.1	$52.7	+38.3
Value of State road contract awards do.	$48.0	$70.0	+45.8
Shipments of portland and masonry cement to and within the State thousand short tons	423	394	-6.9
Mineral production value:			
Total crude mineral value millions	$1,851.6	$2,331.3	+25.9
Value per capita, resident population	$4,748	$5,742	+20.9
Value per square mile	$18,910	$23,810	+25.9

[p] Preliminary.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—The 1977 production of cement increased by 4% from that of 1976. Monolith Portland Cement Co. in Laramie continues to be the only cement plant in Wyoming. According to the State Inspector of Mines Annual Report of 1977, the company produced about 203,000 tons of cement. The types of cement shipped were Types I, II and V, but the majority shipped was Types I and II. From the plant, 43% of the cement was shipped by railroad to the company's terminal in Denver and the remainder was by truck directly to consumers. Virtually all the cement was shipped in bulk form.

Clays.—The production of clay, according to data obtained from the Revenue and Taxation Ad Valorem Tax Div., was about 3.5 million tons compared with 3.2 million tons in 1976. Bentonite was mined by eight companies and four companies mined clay and shale. The production of bentonite was from Big Horn, Crook, Johnson, Natrona, Washakie, and Weston Counties. Crook County was once again the leader in production. Wyoming's bentonite is used in a number of ways but it is primarily used as a drilling mud, in pelletizing of iron ore, and in foundry sand. The leading producers in the State were American Colloid Co., Dresser Industries, Inc., Baroid Petroleum Services, Kaycee Bentonite Corp., and Aurora Metal Co.

An environmental review by the National Park Service concluded that a full-blown environmental statement is not required for American Colloid Co.'s proposed bentonite mine near Lovell. The proposed mine will cover 50 acres and produce about 45,000 tons of bentonite. Production from the mine is expected to begin in 1978.

Wyo-Ben Products, Inc., received authorization from the Public Service Commission to establish substandard clearance on two railroad spurs at Sage Creek and Stucco in Big Horn County. The request was needed to facilitate construction of dust control buildings over loading facilities on the spur lines. The Department of Environmental Quality had requested that Wyo-Ben control the dust at its finished product loading facilities.

Black Hills Bentonite completed its conversion from natural gas to coal at its two plants. The company still uses natural gas for about 20% of its burn to insure continuous burning. Operations at both plants are at capacity. The company did have to cut back at the Worland plant last summer because of a shortage of railroad cars.

Dresser Industries completed their expansion operations during the year. As a result of the expansion, production has increased by about 75,000 tons according to the State Inspector of Mines Report.

NL Baroid Petroleum Services has reached an average daily production of 1,065 tons per day, according to the State Inspector of Mines Annual Report. The company, although not expanding at this time, plans to open a mine near Lovell in the Big Horn Basin. The company is presently converting its dryers from oil and gas to coal. Completion of the coal conversion is expected in 1978.

Feldspar.—Modern Mining and Milling Co., Inc., increased production slightly from the Quien Sabe mine during 1977. The company supplies feldspar for the Bon Ami Co. of Kansas City. Modern Mining made soap bars at the mine for Bon Ami but have stopped because of a lack of a market. The feldspar is not mined and crushed before being shipped to Kansas City.

Gem Stones.—The estimated value of gem stones produced was $200,000 compared with $147,000 in 1976. The Majestic Jade Co. of Riverton continues to be the only gem stone producer in the State.

Gypsum.—The production of crude gypsum increased by 12% over the 1976 production. Production of gypsum comes from Albany, Big Horn, and Park Counties. Calcined gypsum production increased by 10% in 1977. The production was from Georgia-Pacific Corp. and The Celotex Corp. in Big Horn and Park Counties, respectively.

Lime.—The Great Western Sugar Co. and Holly Sugar Corp. produced lime in Big Horn, Goshen and Washakie Counties. The output of lime increased by 15% over that of 1976.

Phosphate Rock.—The production of phosphate increased slightly over that of 1976. This increase follows 2 years of declining production. The only producer in the State is Stauffer Chemical Co. of Wyoming at the Leefe mine in Lincoln County.

Sand and Gravel.—The production of sand and gravel declined by 7% from that of 1976 but the value increased by 2%. The unit value of sand and gravel increased from $1.97 per ton in 1976 to $2.17 per ton in 1977. The major uses of sand and gravel was for roadbase and coverings, concrete aggregate, and asphaltic concrete. Publicly funded projects accounted for about 20% of the tonnage.

Table 4.—Wyoming: Construction sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

	1976		1977	
	Quantity	Value	Quantity	Value
Sand	1,528	2,803	1,242	2,613
Gravel	3,942	7,978	3,842	8,413
Total	5,470	[1]10,782	5,084	11,026

[1] Data do not add to total shown because of independent rounding.

Table 5.—Wyoming: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		1977	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	1,291	3,285	1,111	3,092
Concrete products (cement blocks, bricks, pipe, etc.)	88	282	293	555
Asphaltic concrete aggregates and other bituminous mixtures	1,769	3,330	1,049	2,695
Roadbase and coverings	1,300	2,090	1,788	3,501
Fill	432	745	792	1,032
Other uses	590	1,049	51	150
Total[1]	5,470	10,782	5,084	11,026

[1] Data may not add to totals shown because of independent rounding.

Sodium Carbonate.—Wyoming continues to be the Nation's leading producer of natural sodium carbonate. According to the State Inspector of Mines Report, the trona mined was 11.3 million tons or a 19% increase from that of 1976. The producers, according to rank, were FMC Corp., Allied Chemical Corp., Stauffer Chemical Co. of Wyoming, and Texasgulf, Inc.

Stauffer began construction during the

year on expanding its Big Island refinery. The addition will increase the plant capacity from the present 1.5 million tons to 1.8 million tons annually. Construction is expected to be completed in 2 to 3 years and will add an additional 60 permanent employees.

FMC Corp. has converted its heat source from natural gas to coal. The company added two huge coal-fired boilers to supply the total generating and process heat required to run the plant. The boilers are equipped with pollution control electrostatic precipitators and sulfur dioxide scrubbers. The sulfur dioxide scrubbers use soda ash instead of lime and were manufactured by FMC.

Texasgulf, Inc., completed its first full year of production and added 50 new employees to their growing operation. The plant was the first to be designed to use coal as a heat source. The plant will use about 375,000 tons of coal annually. The company does not generate its own electricity and therefore purchases it from Pacific Power and Light Co.

Allied Chemical Corp. installed equipment costing $5.6 million to control dust. The installation was completed during the year.

The largest sodium bicarbonate processing plant in the world is the Church & Dwight Co., Inc., plant in southwestern Wyoming. The company completed a $9.4 million expansion in the first quarter of 1977. The expansion enables the plant to supply one-half of all the baking soda manufactured by Church & Dwight. Plant capacity is now about 135,000 tons of baking soda a year or about eight times that of the original plant.

Stone.—Basin Engineering Co., Inc., and Wyoming University quarried dimension stone for rubble and rough construction stone. Eleven companies crushed stone at 25 quarries for railroad ballast, roadstone, cement, and other uses. Output declined 12% to 2.43 million tons valued at $7.59 million. Leading producers were Guernsey Stone Co., Morrison & Knudsen Co., Inc., and Wyoming Construction Co.

Among the states, Wyoming ranked fourth in output of crushed marble.

Sulfur.—The recovered sulfur shipments in 1977 decreased by 7% to 47,562 tons. Production of sulfur as a byproduct of sour natural gas increased slightly from 44,000 tons in 1976 to 44,598 tons in 1977. Sulfur production was obtained from five plants located in Carbon, Fremont, Laramie, and Park Counties.

METALS

Copper.—After 70 years of being dormant, the Ferris-Haggerty mine west of Encampment is getting new life. The mine was closed in 1908 but now a mining engineer from Casper has signed a long-term lease on the mine property. The engineer is refurbishing the old mine with the intent of mining copper again.

Iron Ore.—Iron ore shipments decreased to 2.2 million short tons in 1977 compared with 2.4 million short tons in 1976, according to published reports in Skillings' Mining Review of February 25 and March 4, 1978. United States Steel Corp. reported shipments of iron ore pellets from its Atlantic City mine of 1,850,000 short tons. CF&I Steel Corp. had a decrease in production from 491,961 short tons in 1976 to 372,603 short tons in 1977.[3] The ore from this mine is shipped to the CF&I Steel Works in Pueblo, Colo.

Uranium.—Wyoming's production of U_3O_8 increased by 22% to 9,857,000 pounds in 1977. The production was 33% of the Nation's total and Wyoming remains second behind New Mexico in production.

A new uranium operation, Bear Creek mine, operated by Bear Creek Uranium Co., came on stream during the year and is the second mine in the Powder River Basin. Two underground mines in the Powder River Basin came on stream late in the year. The operators were Kerr-McGee Nuclear Corp. and a joint venture of the Tennessee Valley Authority (TVA) and United Nuclear. Stripping operations began at the Lucky Mc Uranium Corp.'s Big Eagle mine in the Gas Hills area. Also in the Gas Hills area, Federal-American Partners, which has been running a milling operation for other mines, is gearing up to resume its mining operation. Mineral Exploration, a subsidiary of Union Oil Co. of California, has made plans to start a uranium operation in Sweetwater County, west of Rawlins. The operation will have an estimated production of 3,000 tons per day. Wyoming Minerals Corp., which has been testing in situ leaching operations in the Powder River Basin, is planning a commercial operation.

The Bear Creek mine and mill located about 70 miles northeast of Casper was formally dedicated on September 22, 1977. The uranium project is a joint venture between Rocky Mountain Energy Co. (RME), a subsidiary of Union Pacific Corp., and Mono Power Co., a subsidiary of Southern California Edison Co. Ore from the mine will be processed through the mill at a rate of 1,000 tons per day. The project will have about 250 employees and an expected life of 15 years.

Federal American Partners announced expansion plans for its mill which could increase the size of the mill from the present 1,000 tons per day to as high as 3,000 tons per day. This is in addition to the mining expansion taking place. Partners has just been operating the mill during the past few years but is now gearing up to mine ore. The ore being processed is from the Lucky Mc mine owned by Lucky Mc Uranium. The partnership also signed an agreement with TVA to mine uranium from acreage under lease to TVA.

Mineral Exploration Co., a wholly owned subsidiary of Union Oil Co. of California, has started preliminary work on a uranium operation 34 miles northwest of Rawlins. The ore trucks are now being assembled near Wamsutter. An application to mine had been filed with the Department of Environmental Quality but was rejected because of incomplete reclamation plans. The company has awarded a contract to Big Horn Construction Co. to pave 31 miles of road from the Wamsutter Crooks Gap road to U.S. Highway 287. A company spokesman stated the basic mine design is near completion and the mill design is on schedule.

Lucky Mc Uranium Corp., a subsidiary of Utah International, received a permit to start mining at the proposed Big Eagle mine south of Jeffrey City. When in full production the mine will have about 280 employees. The ore will be trucked and processed at the Lucky Mc mill in the Gas Hills area. The mine is expected to have about a 10-year life.

Petrotomics continued reconditioning a uranium mill in the Shirley Basin. The mill should be in operation early in 1978. Ore for the mill will come from the Jenkins Project where Getty Oil Co. is removing overburden to get to the ore. The expected life of the operation is about 10 years.

Development work continues at United Nuclear Corp.'s Morton Ranch operation. The operation is a joint venture with TVA. A surface mine is located on the south end of the property and an underground mine is being developed on the north Morton Ranch property. The expected life of the operation when in full production is 10 to 12 years.

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[1] State Liaison Officer, Bureau of Mines, Cheyenne, Wyo.

[2] Skillings' Mining Review. U.S. Steel Shipments From Wyoming - Utah operations. V. 67, No. 9, Mar. 4, 1978, p. 6.

[3] ———.1977 CF&I Steel Corp.'s Shipments of Iron Ore. V. 67, No. 8, Feb. 25, 1978, p. 8.